POWER

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EDITORIALS

Bought or Made Power

Another one of those present-day influences affecting the economies of power generation has landed squarely in our midst.

As a result of the effort of government to "balance the budget," the Revenue Act of 1932 Section 616 fixes a three per cent tax upon electricity supplied for domestic or commercial consumption. Treasury Department Regulations Number 42, Article 40, interprets the Act to exempt from tax all electricity used for industrial consumption.

This automatically relieves from tax all electricity industry generates for its own consumption, and has the effect of placing a price handicap on any purchased electricity taxable under the Act.

Necessarily this will improve the economic aspect of "made power" in certain cases hitherto in the doubtful class.

Low Power Factor A Curable Pest

Of what avail is cheap power if while kilowatt-hours are being saved at the spigot, they are being wilfully wasted by low power-factor at the bung? Low power-factor is the common enemy of both the producer and the consumer. Rate schedules for purchased power are being made generally more favorable where high power-factor is maintained. Special attention is being given to the design of motors, and this, together with a wide range of corrective methods, offers fruitful opportunities for electrical consumers to reduce their power costs.

Feeders may reveal low power-factor loads even with a comparatively high power-factor on the system, since some loads may have a low leading power-factor while others have a compensating low lagging power-factor. Compensation by this method is not always the most economical, and study of the individual loads may easily reveal losses not apparent at the switchboard meters.

Through it all, users will be certain of having the fullest cooperation from the power companies, since low power-factor is a condition of benefit to no one and a pest to all.

1932 is "Scratch"

• A VAST amount of wrong and even destructful thinking is rampant these days, and those of the power field come in for their full share of its consequences.

• ENGINEERS as a general rule are born and educated to use the constructive impulse. Left to their own devices they will, with certainty, turn to building upward.

• BUT TIME after time, ever since nineteen twenty-nine, meritorious and money-saving projects specially attuned to existing requirements, have been scotched by well-meaning persons whose decisions reflect utter lack of confidence in their country's future.

• IT IS increasingly apparent that there will be no progress while potentially competent people look to someone else to bring back prosperity, that they may profit all and contribute nothing.

• LIVING on and in the past is puerile. Nineteen thirty-two is "scratch." Let it be so regarded. We are dealing today with things as they are, and we shall reap as we sow.

The Swing Up

The conviction is widespread—and growing—that the field of industrial power will be among the first to profit by the improvement in business conditions. For two long years water has been piling up behind the economic dam that blocks industrial activity. For two years executives have been learning that production costs must be cut and that power costs can be.

Power equipment that was obsolete when the depression started is two years' more so today—more than two years' more, because obsolescence is measured by the progress of the art of power generation rather than by the lapse of time, as shown by clocks and calendars.

In two years by the clock more than a two-year measure of thinking has been done by engineers with leisure to think and plan, by operators, plant designers and equipment builders. New equipment is ready. Innumerable modernization projects have been fully charted. In many a file the pigeonholed blueprints await only the guns of zero hour, because every decision has already been made.

These facts are common knowledge in the power

field. They give substance to the widespread confidence of those "in the know" that the new industrial advance over the plains of low-cost production will start with a barrage of power-plant activity. In no other way can production costs be established on a profit-making level.

Where Selling Courage Fails

There must be something of a uniform social psychology that makes expressions like these of such wide application: "There are tricks in all trades but mine," "He votes dry but drinks wet"—And to these could well be added another to the same tune—namely: "Everyone should subscribe to the stabilization of prices but me."

On all sides one hears of price demoralization and the necessity of making prices which will assure a fair profit for one's labor. The truth of this is obvious, and there is no trouble finding argument—even absolute conviction—that this must be.

Yet if we could trail the noisiest of the profit defenders to their private offices we would find the attitude completely changed. One would hear in effect, "Yes, the job is worth a profit but—we need the work. The 'X' company has been making terrible prices and we are going to take the order away from them if we have to quote without any profit."

So the "dry voter" at bottom proves himself "all wet" and whether or not he gets the order his action affects all the future prices of his industry.

If members of an industry could be persuaded to practice as individuals what they preach when together, it would be a great thing.

Coal-Stuffed Fuel Oil Has Possibilities

According to a recent dispatch to the *New York Times* from London, the Cunard liner *Scythia* has successfully completed a test run to New York, using a new colloidal fuel, the exact nature of which is secret with the Cunard Company.

With no desire to disparage the value of the report, it should be pointed out that the admixture of fuel oil and pulverized coal in the 60–40 ratio mentioned is not an altogether new idea. It is understood that the process is patented, and it is known that some three years ago the Todd Shipbuilding & Dry Dock Company of Brooklyn conducted experiments on the fuel and collaborated with the American marketing company.

The plan, in general, was to make a mixture of 60 per cent fuel oil and 40 per cent pulverized coal by volume, the coal being held in mechanical suspension by the oil with little or no tendency for separation. It should be emphasized, however, that the mixture was mechanical and not truly colloidal.

The experimental work done in this country was slight compared to the development in England, where samples have been known to stand as long as fifteen months with little tendency to separate beyond the formation of a slight sludge.

The addition of pulverized coal to oil has the effect of increasing its B.t.u. content per unit of volume from 3 to 6 per cent, possibly more. The exact figures depend upon the quality of the coal and the oil used.

Experimenters have also substituted pulverized coke for coal with a still greater increase in B.t.u. content.

The process is of particular interest in maritime service. Its adoption as a stationary power plant fuel is less pressing and consequently more remote, unless there is a decided change in the present relation of the individual fuel prices.

New York-St. Lawrence Power Steps Up

July eighteenth, the Great Lakes-St. Lawrence deep waterway treaty between Canada and the United States was signed. The fact that portions of this development have already been in progress for several years, without the treaty, only adds emphasis to the stimulation that must result from the final settlement of the international questions involved.

Conclusion of the treaty sets the stage for further activity in the development of hydro power at the international section of the river. On ratification of the treaty by the American and Canadian governments, the way will be clear for the interested governments of the State of New York and the Province of Ontario to negotiate with their national governments as to power generation.

Although New York confidently asserts its proprietorship to the water rights, it will, in all probability, require a United States Supreme Court action definitely to determine this question. Tied into this, the matter of jurisdiction of the Federal Water Power Commission is likewise involved. Then there is the matter of equitably apportioning the expense of the American portion of the international development to the waterways and power divisions. Obviously the decisions here will seriously affect the cost, and consequently the delivered price, of the power, and one may expect no hasty decision on this point.

It is evident that there shall be no great overnight transformation of the New York-St. Lawrence hydro power outlook as a result of the signing and presumably the ratification of the treaty. These events do, however, emphasize the inexorable forward momentum of the whole waterways project and the power development which is a great part of it.

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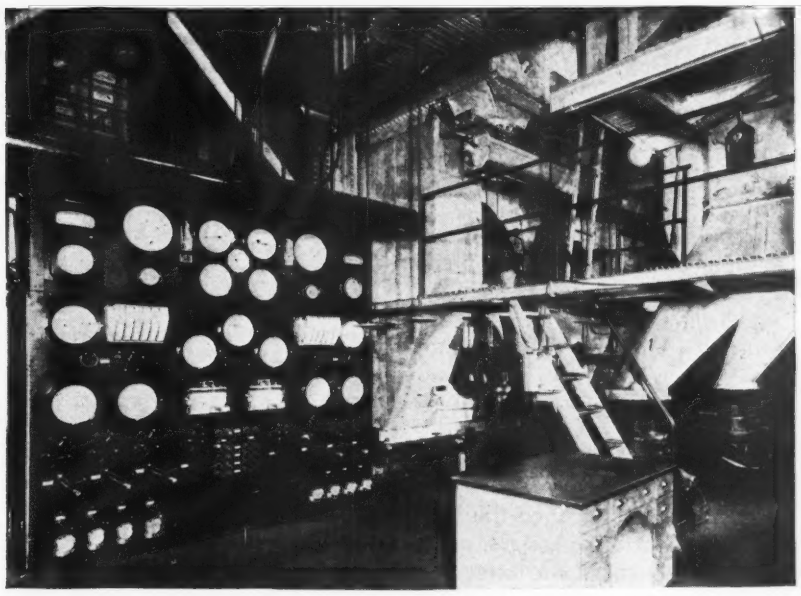
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Pennsylvania Sugar ties new 400-lb. pressure, 500-deg. boilers to old 150-lb. plant. Process steam is delivered through a new 2,500-kva. bleeder back-pressure turbine. Other features are pulverized coal, economizers, and air heaters



Boiler-room instrument and control board

NEW BOILERS AND TURBINES FOR SUGAR REFINERY POWER

CUT FUEL BILL $200,000

AN EXCELLENT example of boiler-house modernization, with attendant savings that promise to exceed $200,000 a year in fuel alone, is to be found at the plant of the Pennsylvania Sugar Co., Philadelphia. The work, recently completed, involved the installation of two large pulverized-coal-fired steam generating units, with economizers and air preheaters, each capable of producing over 300,000 lb. of steam per hour at 400-lb. pressure and 500 deg. temperature with a guaranteed efficiency of 86 per cent, and a 2,500-kva. turbine-generator unit.

The new section of the plant is compounded with the old plant to the end that the turbine bleeds at 90 lb. and exhausts at 10 lb. to process, and the exhaust from the auxiliaries at 150 lb. feeds into the existing 150-lb. steam main. Live steam from the new unit also supplements the process demand through reducing valves when necessary.

The old plant, built in 1902, consists of ten 5,000-sq.ft. and one 10,000-sq.ft. stoker-fired boilers generating steam at 150-lb. pressure, and five engines driving d.c. generators of 3,000-kw. aggregate capacity. These engines exhausted at 10 lb. to process. The 90-lb. process line was supplied with live steam through reducing valves. The restricted furnaces of the old boilers limited the choice of available fuel to two or three grades of low-volatile, high-ash-fusion coal costing around $4.40 per ton.

An average of around 400,000 lb. of steam is required per hour at rapidly fluctuating rates, the steam-flow charts sometimes showing swings of as much as 100,000 lb. per hour over a ten-minute period. A Ruth's steam accumulator was installed in 1928 to lessen the severity of these fluctuations. From 18 to 20 tons of coal per hour were burned under the old boilers and the exit flue gas temperature was around 530 deg. Installation of air preheaters to recover this heat was not feasible, as there was no excess power available to drive the induced-draft fans, and the installation of another engine would have made available an excess of low-pressure exhaust steam.

The few usable coals and the prospect of having the steam pressure reduced on some of the old boilers because of their age led to the decision to install the new steam generating units. Ability to utilize any one of a number of low-priced coals at a high sustained efficiency was the prime requisite. A steam pressure of 400 lb. was selected, as this permitted compounding with the old section of the plant.

Accordingly, four of the old boilers were removed, and in this space were installed two steam generating units, each consisting of boiler, superheater, integral economizer, air preheater, completely water-cooled furnace and steel-clad insulated setting. The steam drums are riveted, while all the other drums have seamless forged shells with heads riveted in. Back of the bare waterwall is 3 in. of shiplap tile which, in turn, is backed with $3\frac{1}{2}$ in. of high-temperature insulating blocks. This is incased in steel plates, which makes the setting air-tight. The headers are spring-loaded to take care of expansion, and forged rectangular waterwall headers are employed.

Four more of the old boilers are to be removed shortly, and the remaining units will ultimately be held in reserve as the changeover progresses.

The air preheaters are of the tubular, three-pass type and are located directly above the boilers. When it is desired to operate the unit on natural draft for a steam output of around 50,000 lb. per hour, the flue gases move in a straight path through the first pass of the preheater

and are then bypassed around the induced-draft fan into the stack.

The economizer tubes are of steel containing 0.2 per cent copper. All boiler and economizer tubes were pickled at the mill and Apexiorized after erection.

Each boiler is served by four 5-ton pulverizers with ample excess capacity. As the plant load at present requires about 15 tons of coal per hour, there is liberal provision for handling almost any kind of coal. Several kinds of low-priced coal have been tried to date and have been handled with equal facility. The pulverizers are driven by geared mechanical-drive steam turbines and are located at the basement level.

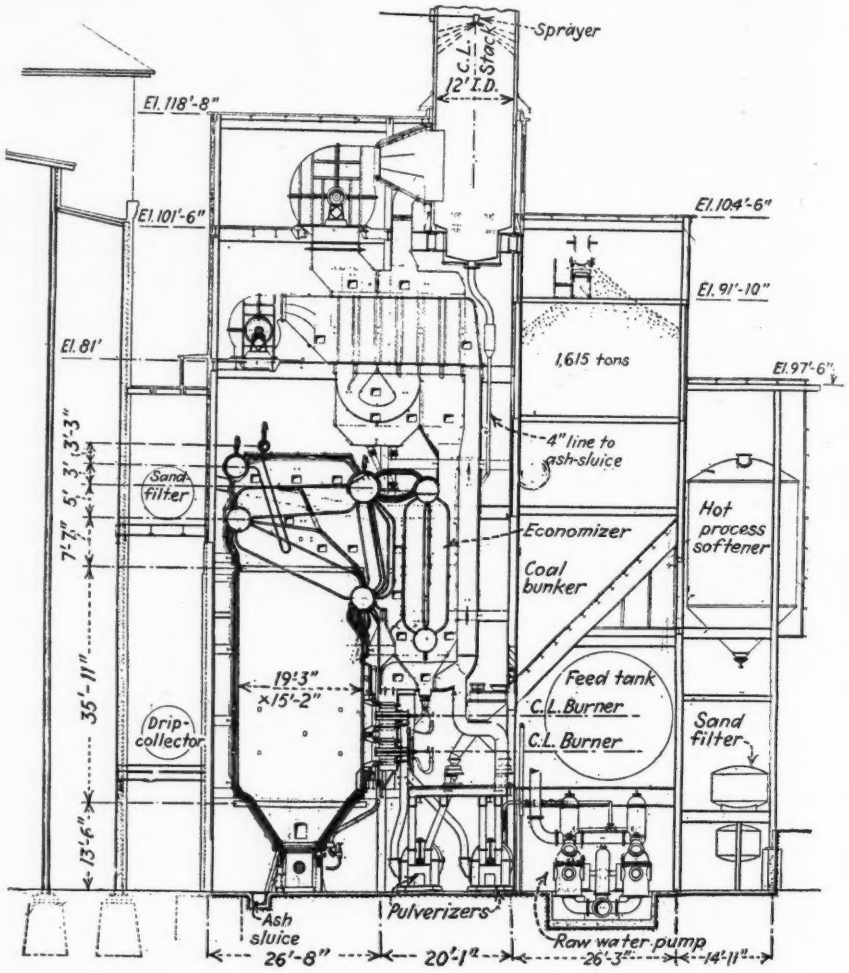
Variable-speed d.c. motors drive the feeders which are on the firing floor in front of the boilers. Four flare-type burners, arranged in groups of two, are provided for each furnace. These are toed in slightly to avoid flame impingement against the walls.

As the auxiliaries for the new units are steam driven at 400 lb., there is no means at present for starting them until this pressure has been reached. Hence, oil is employed for starting, and is capable of developing up to 100,000 lb. of steam per hour with natural draft. The oil has been used alone on Sundays when the load is around 50,000 lb. of steam per hour or less, although it has been possible to operate with pulverized coal on a load of 35,000 lb. per hour, which represents a flexibility of nearly 10 to 1.

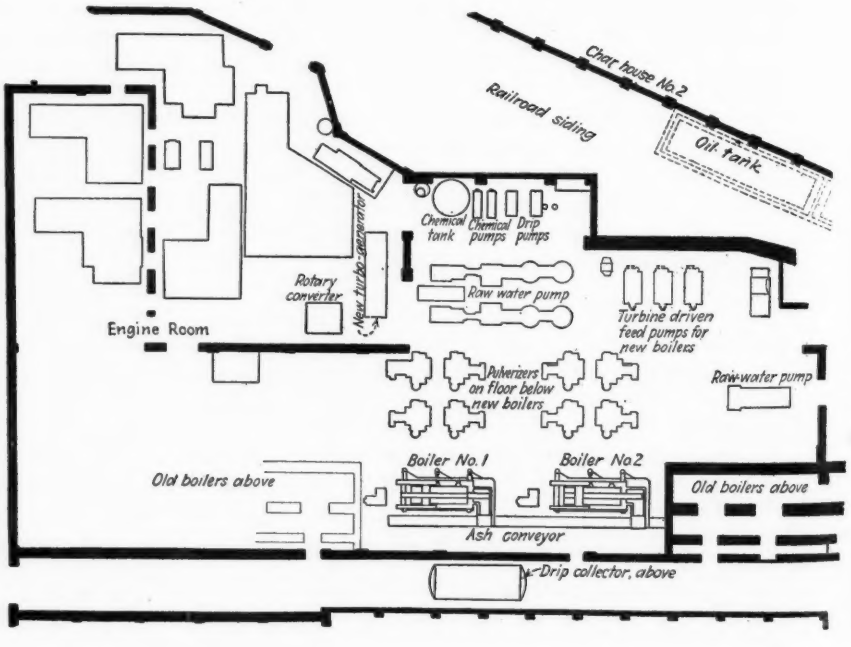
The procedure in starting is to feed the new boilers by one of the old 150-lb. steam pumps. When ready to jump to 400 lb., the steam valve is closed. As soon as 400 lb. is reached, the high-pressure feed pumps and the fans of the new units are started.

The oil burners, which are of the steam-atomizing type, are inserted through the centers of the pulverized coal burners, and steam is supplied at 150 lb. Power for pumping the oil comes from the engine generators.

Each boiler is provided with a 100-ft. steel stack, lined with radial brick laid in acid-proof cement. Between the steel and the brick is a coat of red lead, a coat of acid-resisting paint, and a $\frac{1}{4}$-in. layer of asbestos and gilsonite. Stack sprays have been installed to arrest the fly ash, which is collected in a cinder sluice below.



General arrangement of new boilers and combustion equipment



Plan showing location of new and old power equipment

Furnace ashes are removed by a 20-in. screw conveyor on a 14-in. water-cooled hollow shaft. The discharge is through the end wall into a closed compartment, which is periodically flushed out. All of the ash is sluiced to a pit and removed to cars by a crane.

The coal is delivered by barge and unloaded by a locomotive crane, either to the stock pile or to a scraper conveyor which delivers through a magnetic separator to a 75-ton crusher. Inside the coal bunkers are installed $\frac{3}{4}$-in. pipes, perforated at the bottoms and connected with a CO_2 supply for the purpose of smothering any fire that might occur.

Boiler Feed Water From Three Sources

Boiler feed water is taken from three sources. Condensate at 90-lb. pressure from the vacuum pans enters the water-conditioning plant by way of the deaerating heater where it flashes to 10 lb. pressure. Condensate at 10 lb., which carries oil from the engines and pumps, is passed through sand oil filters. The make-up, which is taken from the Delaware River, is heated to 125 deg. in the barometric condensers of the evaporators and pans and passes through the heat exchanger of the continuous blow-down system, then through jet heaters supplied with 10-lb. exhaust steam and finally to the settler of the lime-soda hot-process softener.

From the settler the clarified water passes through sand filters to the deaerating heater, where it is joined by the 90-lb. condensate and the 10-lb. condensate from the oil filters. The deaerating heater discharges directly into the two boiler feed storage tanks, each of which has a capacity of 450,000 lb., which is equivalent to an hour's operation.

Both tanks are provided with tubular heaters to maintain a temperature of 240 deg. F. Phosphate is fed into the feed pipe as it enters the lower economizer drum. Boiler feed is handled by three four-stage turbine-driven pumps, any one of which will handle up to 350,000 lb. per hour.

In a sugar refinery it is important to detect instantly the presence of any sugar that may get into the feed system, as sugar not only has an acid reaction, but, if present in large quantity, will adhere to the boiler and turbine surfaces. Therefore, a chemist's table has been placed on the operating floor, and four sugar detectors indicate by bell and light the presence of sugar contamination. This is shown on page 63.

The speed of the forced- and induced-draft fans, the rate of coal feed to the pulverizers, secondary air to the burners, and the furnace draft are all automatically controlled.

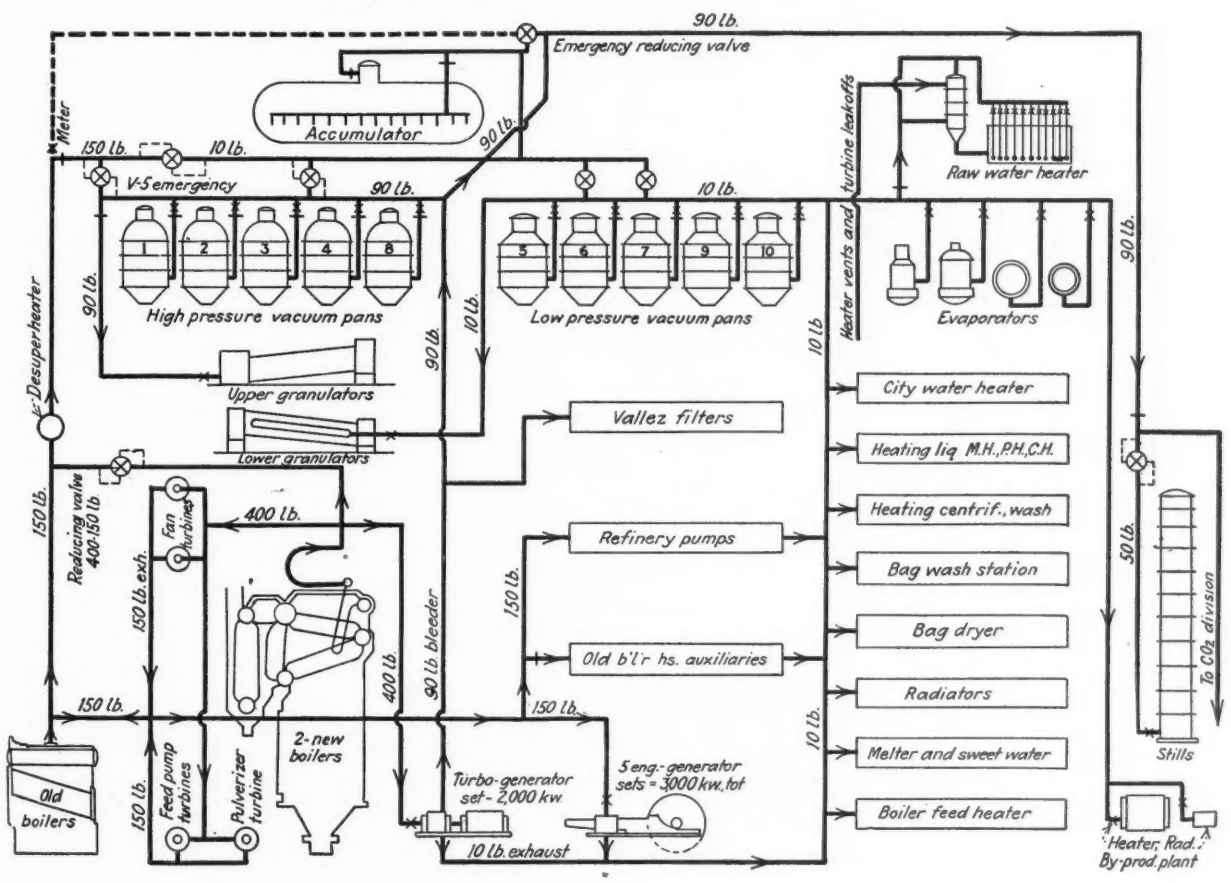
All Piping Seamless

All steam piping is seamless, with bends and welds generally employed instead of fittings and flanges. Such valve flanges and the few fittings that are necessary are of Van Stone type. All gate valves are of chrome-nickel steel with Nitralloy seat rings and stainless steel disks and stems.

A large amount of steam of fluctuating demand is required for process, but here the by-product idea has been developed to the extent that the heat balance has been improved materially.

A large proportion of the molasses from the refinery operation is used in the manufacture of industrial alcohol, for which the 90-lb. exhaust steam is reduced to

Diagram showing distribution of steam to factory processes



50 lb. and employed in distilling. The CO_2, as a by-product of the distillation process, is compressed to produce dry ice and thus increases the power load to balance the exhaust-steam demand.

As previously stated, the engines operate on 150 lb. steam and exhaust at 10 lb. The turbine operates on 400 lb. steam, bleeds at 90 lb., and exhausts at 10 lb. The auxiliaries for the new boilers are all steam-driven, with the exception of one spare motor-driven feed pump, and exhaust at 150 lb., the quantity of this exhaust being from 20,000 to 30,000 lb. per hour on week days and about 10,000 lb. on Sundays. The demand for 150-lb. steam was a primary factor in the selection of steam-driven auxiliaries.

Lines at Two Pressures Tied Together Through Reducing Valve and Desuperheater

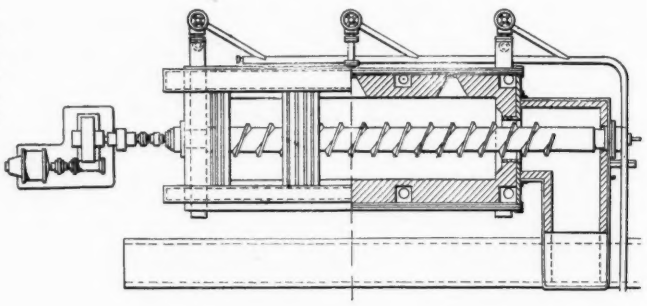
Reference to the steam distribution diagram will show that the 400-lb. steam, in addition to supplying the main turbine and the boiler auxiliaries, passes through a reducing valve and desuperheater to the 150-lb. line, which supplies the steam engines, refinery pumps, old boiler-house auxiliaries (when in use) and the high-pressure vacuum pans at 90 lb. This 90-lb. line is also connected with the bleeder on the turbine, and supplies the distillery, the vallez filters and the CO_2 plant.

10-Lb. Exhaust Line

The 10-lb. exhaust line from the engines, turbine, refinery pumps and oil boiler auxiliaries supplies the various refinery heaters, the feed heaters and the plant heating system, as well as the low-pressure vacuum pans and evaporators. There is also a connection to the low-pressure side of the reducing valve on the 150-lb. line. To this is connected the accumulator, which takes care of the fluctuation in the demand for both the 90-lb. and the 10-lb. steam.

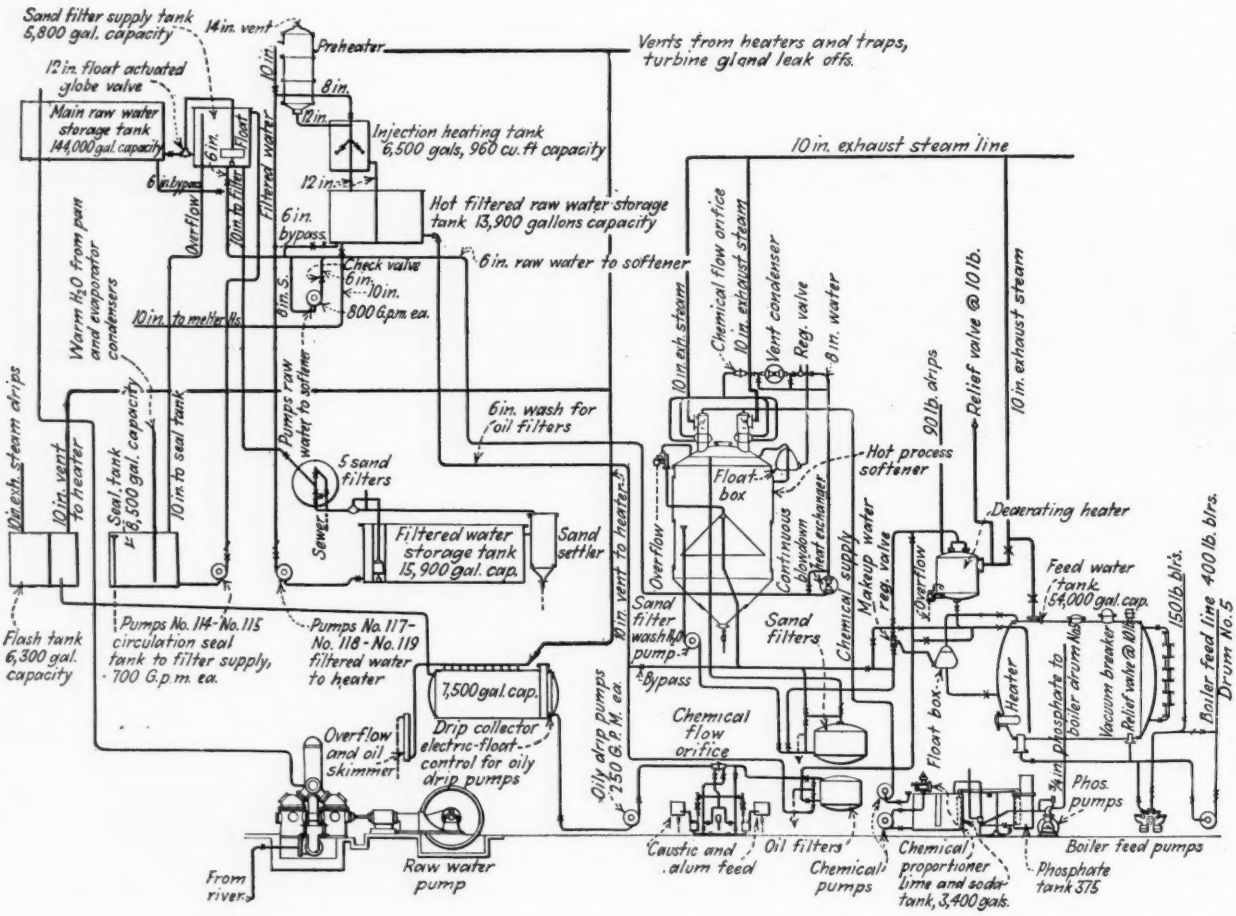
Meters have been placed on all important lines and at process vessels, so that a close control of operation can be maintained at all times.

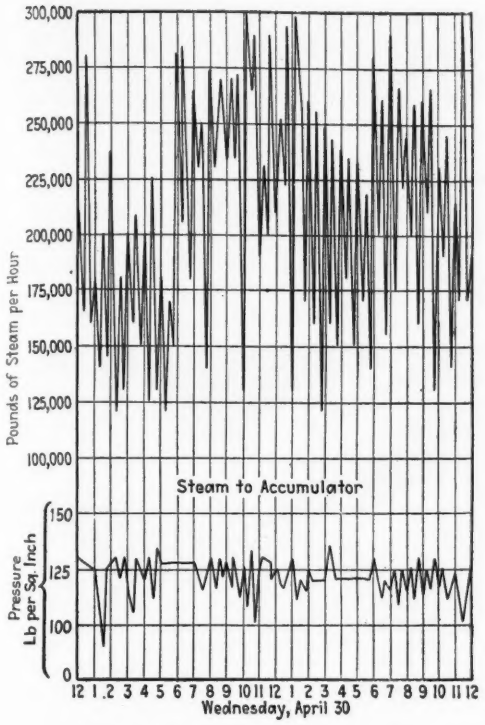
Much of the power used in the plant is direct current except that for the "dry-ice" division. For the purpose of



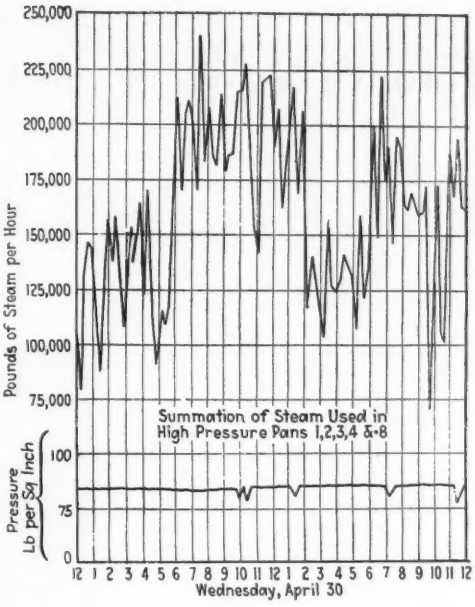
Ash from the furnaces is removed by a 20-in. screw conveyor on a 14-in. water-cooled hollow shaft. Discharge is to a closed compartment which is periodically flushed

Diagram of feed-water heating and treatment system. Boiler feedwater is taken from three sources: vacuum-pan condensate, engine and pump condensate, Delaware River makeup

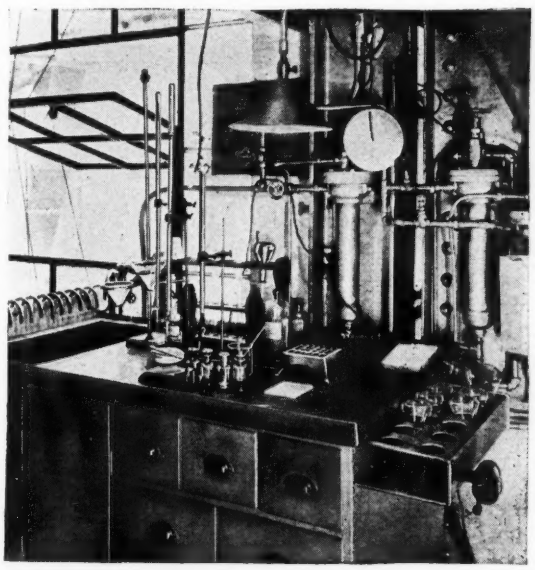

Sand filter supply tank 5,800 gal. capacity
14 in. vent
12 in. float actuated globe valve
Main raw water storage tank 144,000 gal. capacity
6 in. bypass
Overflow
10 in. to filter
Filtered water
Preheater
10 in.
8 in.
12 in.
Injection heating tank 6,500 gals, 960 cu. ft capacity
12 in.
Hot filtered raw water storage tank 13,900 gallons capacity
6 in. bypass
Check valve
6 in.
10 in.
800 G.p.m. ea.
6 in. raw water to softener
10 in. to meter lls
Warm H2O from pan and evaporator condensers
Pumps raw water to softener
6 in. wash for oil filters
5 sand filters
Sewer
Filtered water storage tank 15,900 gal. cap.
Sand settler
10 in. exh. steam drips
10 in. vent to heater
Seal tank 8,500 gal. capacity
10 in. to seal tank
Flash tank 6,300 gal. capacity
Pumps No. 114-No. 115 circulation seal tank to filter supply, 700 G.p.m. ea.
Pumps No. 117-No. 118-No. 119 filtered water to heater
10 in. vent to heaters
7,500 gal. cap.
Drip collector electric-float-control for oily drip pumps
Overflow and oil skimmer
Oily drip pumps 250 G.P.M. ea.
From river
Raw water pump
Vents from heaters and traps, turbine gland leak offs.
10 in. exhaust steam line
10 in. exh. steam
Chemical flow orifice
10 in. exhaust steam
Vent condenser
Reg. valve
8 in. water
90 lb. drips
Relief valve @ 10 lb.
10 in. exhaust steam
Hot process softener
Float box
Continuous blowdown heat exchanger
Chemical supply
Makeup water reg. valve
Overflow
Deaerating heater
Feed water tank 54,000 gal. cap.
Sand filter wash H2O pump
Bypass
Sand filters
Chemical flow orifice
Float box
Heater
Vacuum breaker
Relief valve @ 10 lb.
150 lb. b'rs.
Boiler feed line 400 lb. b'rs. Drum No. 5
Phos. pumps
Caustic and alum feed
Oil filters
Chemical pumps
Chemical proportioner lime and soda tank, 3,400 gals.
Phosphate tank 375
Boiler feed pumps



Steam required by accumulator during typical week day



Steam used in the high-pressure vacuum pans is bled from the new turbine and is supplied at practically constant pressure regardless of load fluctuations



Chemist's tables on operating floor used to detect sugar contamination of boiler water

providing flexibility in operation as between the a.c. and d.c. loads, a 1,000-kva. rotary converter has been installed in the turbine room.

Construction work on the remodeled plant was started May 1, 1931, and the first boiler was placed in operation late in January, 1932; the second unit went into service about a month later. The plant was designed and erected by the engineering department of the Pennsylvania Sugar Co., under the direction of Dan Gutleben, chief engineer, to whom *Power* is indebted for the information in this article.

Principal New Equipment in Power Plant of the Pennsylvania Sugar Company

Boilers—Two Riley-Badenhausen, each rated at 300,000 lb. of steam per hour at 400 lb., 500 deg. F.; 10,234 sq.ft. heating surface per boiler. All drums and tubes Apexiorized.

Furnaces—Volume, 10,425 sq.ft. each; bare waterwalls and steel-clad insulated setting; 5,546 sq.ft. water wall surface per boiler.

Economizers—Integral type, 5,000 sq.ft. each.

Air preheaters—Tubular three-pass, 20,632 sq.ft. each.

Superheaters—Convection type, 435 sq.ft. each.

Ash removing screw—Water cooled.

Pulverizers and feeders—4 per boiler, 5 tons each. Pulverizers driven by Westinghouse turbines, feeders by variable-speed d.c. motors.

Coal burners—4 per furnace, flare type with steam atomizing oil burners.

Combustion control—Craig mechanical type (A.W. Cash Co.) All above equipment furnished by Riley Stoker Corp.

Soot blowers.....Vulcan Soot Cleaner Co.

Water columns.....Diamond Power Specialty Corp.

Forced and induced draft fans, each driven by a Westinghouse turbine, capacity: forced draft 108,000 c.f.m., induced draft 200,000 c.f.m.....B. F. Sturtevant Co.

Oil burners.....National Airoil Burner Co.

Flow meters, pyrometers, pressure gages, water level gages, Brown Instrument Co.

Draft gages.....Hays Corp.

CO_2 indicators and recorders (Ranerex).....The Permutit Co.

Ash handling equipment .....Allen-Sherman-Hoff Co.

Soot removal equipment .....Pennsylvania Sugar Co.

Coal handling equipment.....Sterns Conveyor Co.

Bunkers, gates, etc.....Pennsylvania Sugar Co.

Coal crusher.....Williams Patent Crusher & Pulverizer Co.

Magnetic separator.....Dings Magnetic Separator Co.

Scales.....Richardson Scale Co.

Feed tanks (two 450,000 lb. capacity)....Downingtown Iron Wks.

Feed water regulators (Copes).....Northern Equipment Co.

Feed pumps (Cameron).....Ingersoll-Rand Co.

Auxiliary turbine drives.....Westinghouse Elec. & Mfg. Co.

Water conditioning equipment—hot lime-soda process heaters, settler, filters deaerating heaters, continuous blowdown, phosphate feed .....Cochrane Corp.

Raw water and condensate pumps.....Allis-Chalmers Mfg. Co.

Motors .....Crocker-Wheeler Co.

Fuel oil pumps .....Kinney Mfg. Co.

Fuel oil heaters.....Griscom-Russell Co.

Piping.....Fabricated by W. K. Mitchell Co. Erected by Pennsylvania Sugar Co.

Fittings.....Reading Pratt & Cady Co.

Valves (gate).....Chapman Valve Mfg. Co.

Valves (non-return, check and globe)....Schutte & Koerting Co.

Safety valves.....Consolidated Ashcroft Handcock Co.

Relief valves (multiport).....Cochrane Corp.

Reducing valves (400-150 lb.).....Ruths Steam Storage Co.

Insulation for boiler walls, piping, tanks & flues..Philip Carey Co.

Sugar detectors .....Leeds & Northrup Co.

Radial brick stack lining...Alphonse Custodis Chimney Const. Co.

Structural Steel .....McClintic Marshall Co.

New turbine (3,000-hp. bleeding at 90 lb., exhausting at 10 lb., Moore Steam Turbine Corp.

Generator, 2,500-kva., 2,300-volt, 3-phase, 3,600-r.p.m., General Electric Co.

Rotary Converter, 1,000-kw., 2,300-volt a.c., 230-volt d.c., General Electric Co.

PUSHBUTTON CONTROL PERMITS CENTRALIZED BOILER OPERATION

By EDWARD S. BRISTOL

Combustion Engineer, Leeds & Northrup Company

Pushbutton control of boilers under certain conditions may serve as a substitute for full-automatic combustion control. To insure reliable operation the equipment must be selected with particular attention to the severe conditions of boiler-plant operation

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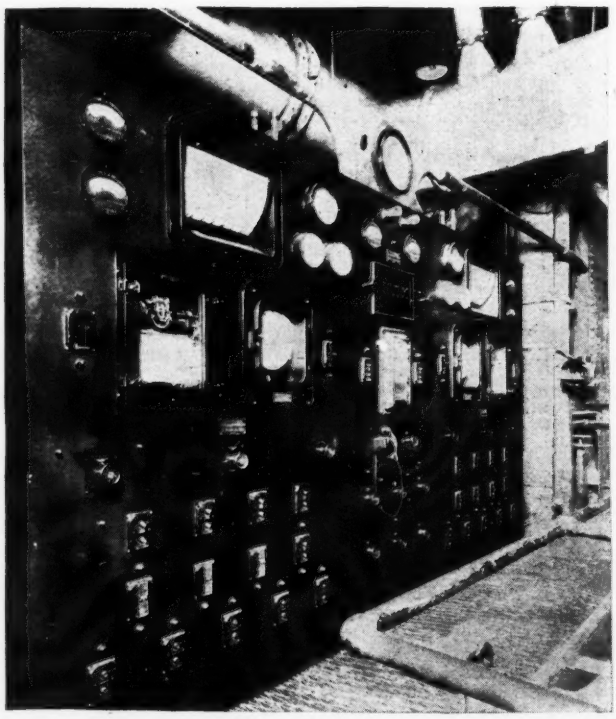
BECAUSE of its apparent simplicity, and because it is generally classed as accessory equipment, pushbutton control may not be laid out with as much care as it should be to give reliable and satisfactory service. Boiler-plant conditions are more severe than those for which most control equipment is designed. Selection of components of a pushbutton system for such service should, therefore, be made with care. The designing engineer should not lean too heavily upon the discretion of his purchasing agent and the ingenuity of the erection engineer.

Increases in boiler ratings during the last decade have brought with them corresponding larger auxiliaries, controls and boiler-room dimensions. As a consequence, a point has been reached in the layout of many plants where boiler operation by unaided manpower has become practically impossible because of the effort necessary to manipulate some of the equipment and the distances between the various controls. This condition has been one of the factors that have led to extensive use of automatic combustion control.

Some power-plant designers are unwilling to adopt full automatic equipment because of conservatism or their belief that conditions in a particular plant do not warrant the expenditure for its installation. Under such conditions it is common to provide remote pushbutton operation on some or on all boiler auxiliaries and controls.

Pushbutton control includes part of the functions performed by an automatic-control system. It substitutes mechanical power for manpower in operating the various dampers, throttle valves or rheostats, and centralizes the means for directing the application of this power. By decreasing the physical labor needed for boiler operation it lessens the inclination to neglect small but necessary changes in draft and fuel supply. Pushbutton control, together with a good set of instruments and gages to give the operator a clear picture of what he is doing, form a basis from which good results can reasonably be expected. The gap between such control and complete automatic control lies in the absence of means for relieving the operator from constant attention to repetitive adjustments.



Panel provides pushbutton and automatic control for two pulverized-coal fired boilers, Mistersky Power Station, City of Detroit

In a pushbutton control system the elements are: the drive unit (comprising a motor and reduction gearing), the linkage connecting the unit to the damper or other device to be controlled, the motor relays (when used) and the pushbuttons. Since these elements constitute the tools of the boiler operator, the conditions under which they will be used must not be overlooked.

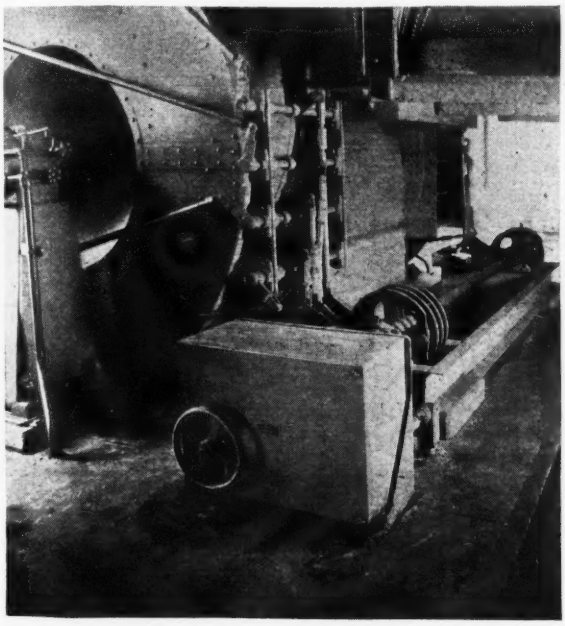
The most important part of a pushbutton system is the drive unit. This should have a large excess of power over the requirements of normal operation and should be of sturdy design, capable of consistently reliable service with little attention under dusty or other unfavorable conditions.

Reduction gearing should be of a sufficiently high ratio to give a final drive speed that will enable the operator to make close settings without overshooting. Slow action may appear undesirable to some, because there

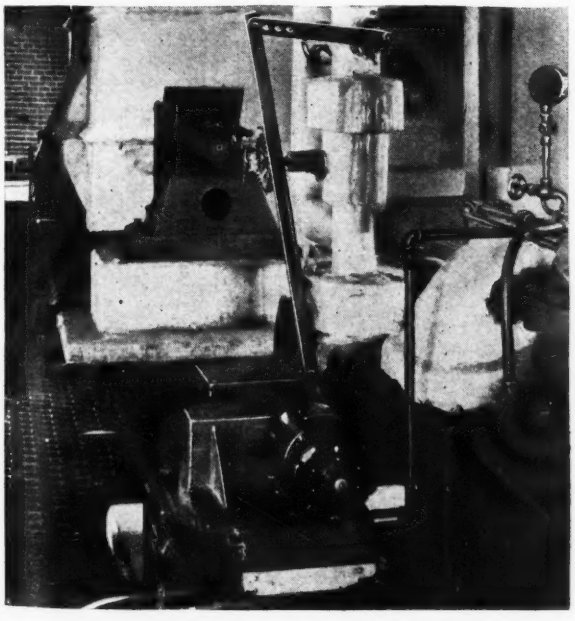
is a common tendency to require something to happen quickly when a button is pressed or a manual change is made.

An advantage of suitable automatic control is that it eliminates unnecessarily large changes and continual overshooting that usually occur with manual control. The tendency of an operator to over-adjust is aggravated by the delay which occurs before the change is completely shown by the instrument indicating the change. Conditions favorable to accurate manual control can be established by employing a drive-unit speed designed to prevent changes being made at excessive rates.

A speed giving travel over the complete control range (damper closed to damper open or equivalent for other devices controlled) in approximately one minute is believed to be well suited to average operating conditions. It is desirable to employ a motor that will give a reasonably constant speed under all conditions. A series motor has poor speed characteristics for this type of service, but the shunt motor is suitable for direct-current applications and the polyphase squirrel-cage general-purpose induction motor for alternating-current.



Motor drive on fan inlet vanes



Motor drive on a fan-turbine throttle valve, Sinclair Refining Company, Wellsville, N. Y.

Speed-control equipment for motor-driven auxiliaries can frequently be obtained with pilot-motor attachments for remote pushbutton operation, for example, field rheostats, drum controllers and brush-shifting mechanism. These pilot motor attachments are generally designed specially for the control device which they are to operate. They make possible a neater combination than is possible with a separate drive unit. In some cases, however, it will be found that the design is not well suited to boiler-plant service, so that the separate drive unit may prove to be the wiser choice.

One of the most important parts of the drive unit is the limit-switch mechanism. It is essential for reliable service that the limit switches be positive and quick-acting, unaffected by dust and stable in adjustment. The glass-inclosed mercury switches have ideal characteristics for this service. They are available with inert-gas-filled bulbs, so that the mercury will remain fresh and clean after millions of operations. It is a simple matter to combine with the limit switches similar switches for the operation of signal lamps on the boiler control board, so as to indicate to the operator when the damper or other device has reached an extreme position.

The linkage of the drive unit to the mechanism to be operated must often be of special design to conform with local conditions. The layout should be simple. Provision for some form of manual operation should be made. Direct mechanical connections should be used whenever possible.

Bearings, bevel gearing, and similar devices are to be avoided, as linkage of this character generally accumulates dust and is placed where frequent lubrication is inconvenient. In simplifying the linkage, however, the drive unit itself should not be mounted where it will be difficult to inspect. Control equipment should be given periodic inspection and attention as a part of the plant maintenance schedule.

For motor-reversing relays the important requirements are sturdy construction, a dust-tight inclosing case and a good mechanical interlock to prevent electrical troubles that would result if both relays were closed at once. A systematic arrangement of pushbuttons on the control board is conducive to correct operation, particularly under emergency conditions. Where the drive unit is far from the control board, local pushbuttons will be found a great convenience for turning the drive shaft into position for connecting up the linkage and for use when inspecting the unit.

In selecting pushbutton control equipment it is generally easily possible to choose types that are adapted to an automatic combustion control system. By exercising a little forethought in laying out the pushbutton system, the cost of installing full automatic control later will be greatly reduced.

Improved efficiency and operation have resulted from full automatic combustion control in many boiler plants. It is therefore wise to prepare for its ultimate use in many cases where automatic equipment is not included in the original installation. Full advantages of push-button control will thus be available from the outset.

Detailed instructions are here given for adjusting the various parts of a floor selector on an Otis signal-control micro-leveling high-speed elevator

By WILLIAM DEVAUGHN
New York City

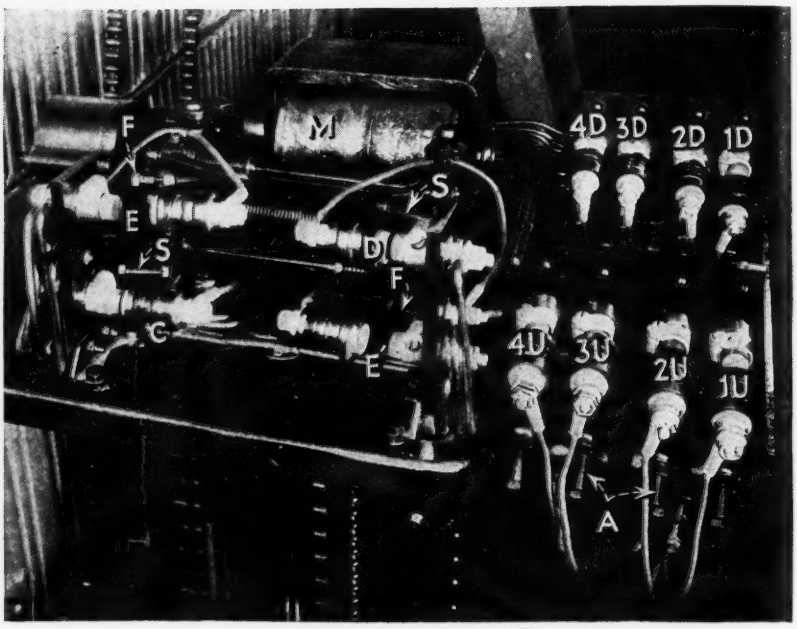


Fig. 1—Selector top. Stopping contacts at right, micro-leveling contacts at left

ADJUSTING FLOOR SELECTORS FOR SIGNAL-CONTROL

FLOOR selectors are required on all automatic-type elevators. On an Otis signal-control elevator the selector performs three important functions: It stops the car at the floors for which buttons have been pressed, levels the car at the floors and operates the signals necessary for efficient elevator service.

The selector, Fig. 4, may be considered a miniature elevator traveling in a hoistway wherein is conveniently grouped the operating equipment. A traveling crosshead, *C*, representing the elevator, is driven vertically by a steel tape attached to the car and wound on sheaves at the top of the hoistway. Connection between the tape-sheave shaft and the vertical screw that drives the selector crosshead is made by a chain drive and reduction gears. Pressure on any hall or car button energizes a corresponding stationary contact on the selector. Contacts on the crosshead pick up this signal as the car approaches the desired floor, and the stopping operation is initiated on the controller. The final stop at floor level is controlled by selector cams and contacts.

On the selector are what is known as floor boards, *B*, Figs. 5 and 6, one for each floor at which stops are to be made. These floor boards are straight bars on which are mounted the up and the down contacts for initiating car stops at floors; contacts for illuminating the hall lanterns, to operate lights in the hall and the car-position indication; and other signal units. The floor boards are clamped to three vertical bars so that they may be adjusted.

At the top of the selector, Fig. 1, which is for a Type *2SLU* control, are two sets of contacts. On the right the two rows, with four contacts each, have to do with various circuits in the control system and the slowing down of the elevator to micro-leveling speed. Contact *1U* controls the accelerating switch; *2U* is in circuit with a resistance connected in parallel with the selector pawl-magnet coil; *3U* is in the up-motion auxiliary field-switch circuit and *4U* is in circuit with the premature door-operating coil. Contact *1D* is in the hall-light-coil circuit, *2D* is the leveling switch, *3D* is in the down-motion auxiliary field switch, and *4D* is in the circuit of the premature door-operating contact.

These contacts are closed by weights and opened by movement of the crosshead. Two vertical rods, *R* and R_1, Fig. 4, connect to the contacts at their top ends and are connected at their lower ends by a rod and angles, Fig. 7, so that when one rod moves up the other goes down. On these rods are U-bolts *U*, one on each rod for each floor at which stops are to be made. As the car approaches a floor at which a stop is to be made the pawl magnet *P*, Figs. 2 and 4, is de-energized and the pawls are allowed to drop out and engage the U-bolt corresponding to the floor to be stopped at. As the car slows down, the selector crosshead continues to move and, through the pawl engaged with the U-bolt, moves the vertical rods to open the two rows of contactors at the right, Fig. 1. Thus the car is gradually brought to micro-leveling speed.

The four contacts on the left, Fig. 1, are for micro-leveling, two for high speed and two for slow speed, and are closed by magnet coil *M* when the car is started. These contacts also connect to two vertical square rods *I*

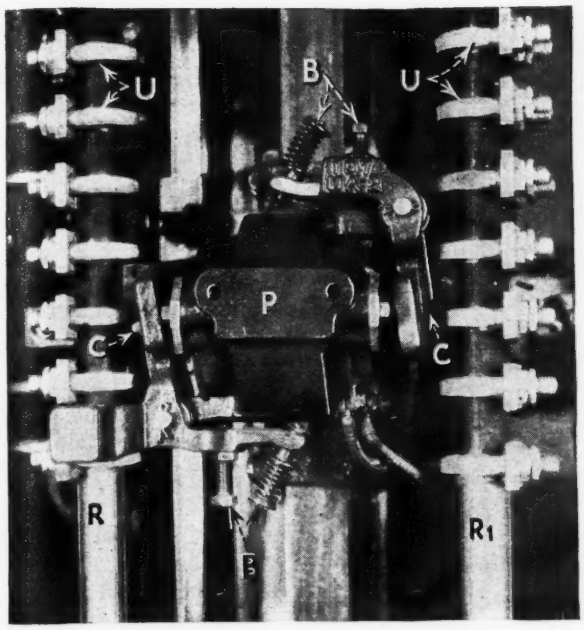


Fig. 2—Pawl magnet on selector crosshead

ELEVATORS

that pass through two roller arms *A* carried on the selector crosshead, Figs. 4 and 5. When coil *M* is energized, the square rods are rotated to separate the roller arms to clear the leveling cams *L*. These cams are mounted on a shaft driven from the same gearing as the crosshead screw and control the slow-speed leveling at the floors.

During stopping, when *2D* contact is opened it breaks the circuit to magnet coil *M* and allows the high-speed leveling contacts to open and the roller arms to close toward the cams. One of the roller arms strikes a cam and prevents the slow-speed micro-contacts from opening until the cam has centered between the two roller arms, Fig. 5. Opening the slow-speed contacts stops the car level with the floor if the equipment is in proper adjustment.

When the elevator is installed, the floor boards or the selector are properly adjusted and should not require further attention. This adjustment is made by placing the car platform level with the top or the bottom landing. Then, with the selector disconnected from the tape-sheave shaft, the selector crosshead is adjusted to a position where the floor boards will have to be moved a minimum distance to bring them to a correct position. A floor gage is fastened to the crosshead, and each floor board is adjusted so that it is in exact line with the gage when the car is level with a corresponding floor.

Fig. 3 shows the dimensions for a floor gage for a Type *2SLU* controller and mounted by bolts *G* on the brush panel, Fig. 7. The gage for other types of control may vary slightly from the one shown. If a gage is not at hand it is well to obtain one from the manufacturers in case checking the position of some of the floor boards should be required.

The normal or release position of the U-bolt rods is adjusted by means of a bumper *B* at the bottom of the selector, Figs. 4 and 7, so that the bell crank that connects to the up rod *R* moves an equal distance above and below a horizontal center line when its pivot is raised $\frac{13}{16}$ in. The tie rod *T* between the two vertical rods is used to accomplish the same adjustment on rod R_1 as given down rod *R*. The bumper and tie-rod adjustments are made at the factory and under normal conditions should not require attention after the equipment is in place.

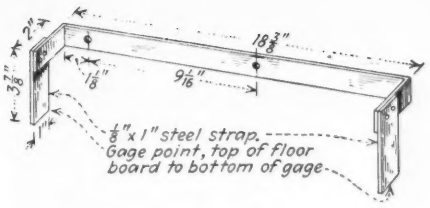


Fig. 3—Gage for setting floor board on selector

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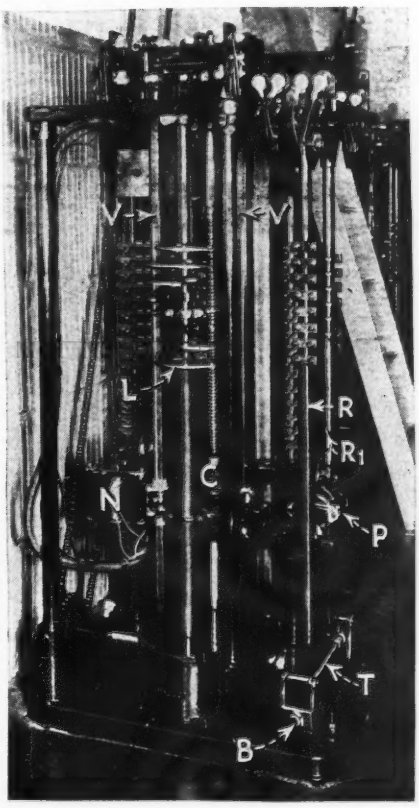
Fig. 4—Floor selector for Otis Type 2SLU control



At the time the floor boards are adjusted the U-bolts should be set. This is done by raising up U-bolt rod *R* $\frac{13}{16}$ in. and securing the rod in that position. With the rods blocked in position and the car level with the landing the U-bolt on the up rod should be adjusted so that the up pawl just slips under it. On the down rod the U-bolt is adjusted so that the down pawl will just pass over it. There should be no clearance between the U-bolts and the pawls and the U-bolts should be locked securely in place. The pawls are shown engaging the U-bolts at *C*, Fig. 2. Engagement of the pawls with the U-bolts is adjusted by bolts *B*. This adjustment should be made to allow the pawls to engage the U-bolts with a firm contact.

When the floor boards and U-bolts are adjusted, also set the cams for the slow-speed micro-leveling control. With the car level with the floor, the leveling cam is set so that it will be in line with and will clear by equal distances the rolls in the two arms on the selector crosshead. In Fig. 5 cam L_1 is shown in the correct position with relation to the rollers in arms *A*, when the car is level with a floor landing.

After final setting of floor boards and U-bolts, place the car level with the top floor and mark the position of the crosshead guide arms on the square vertical bars. This marking is necessary and will be found convenient should the tape or chain break on the selector drive. To obtain approximate setting of the

selector, the crosshead is run by hand to the marks on the square bars and the car set at the top floor. The selector is then connected to the drive and a test made to see how the car levels at the floors. It may be necessary to make changes in the drive to bring the car level with the floors. If the adjustment is small it can be made by shifting the selector's sprocket wheel on its hub. Where this is not sufficient the chain may be opened and the crosshead moved by the sprocket wheel.

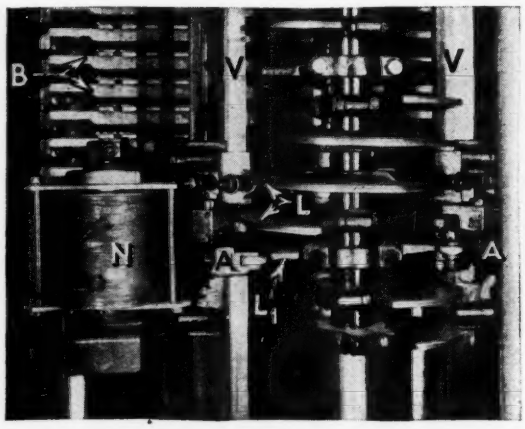
The stopping contacts at the top of the selector are adjusted by adjusting screw *A*, shown on the front row of contacts, Fig. 1. Similar adjusting screws are on the other row of contacts. Contacts 1*U*, 2*U* and 3*U* are adjusted for the up motion of the car, and although these settings vary somewhat for different car speeds the following are about correct for car speeds of 700 to 800 ft. per min.: Contact 1*U* is adjusted to open when the car is 18 in. below the floor, 3*U* to open when 12 in. below, and 2*U* to open when it is 5 in. below. Contact 1*D* may be adjusted with the car moving in either direction and is set to open when the car is within 8 in. of the floor.

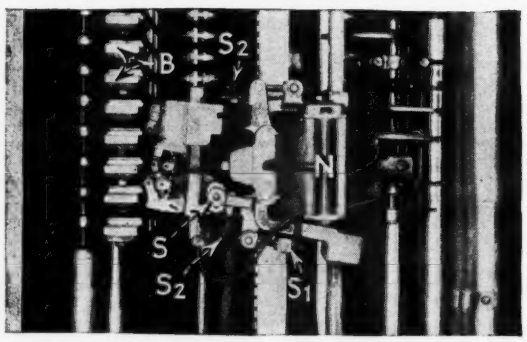
Contacts 2*D* and 3*D* are set with the car in the down direction. They are adjusted so that 2*D* opens when the car is within 5 in. of the floor and 3*D* when the car is 12 in. above the floor. Contacts 4*U* and 4*D* control the opening of the doors and are adjusted to cause the doors to open at the desired time.

Opening of the micro-leveling contacts on the selector is timed by the adjusting screws *F* on the high-speed contacts and *S* on the slow-speed contacts. The fast-speed contact *E* is adjusted to open when the car is 5.5 in. above the floor and contact E^1 to open when the car is 5.5 in. below the floor. In each case the car is moving toward the floor. The two slow-speed micro-contacts *C* and *D* are adjusted to open when the car is within $\frac{3}{4}$ in. of the floor. Contact *C* is for down motion and *D* is for up motion of the car.

DISTANCE OF CAR FROM FLOORS WHEN HALL STOPPING CONTACTS OR BRUSH MAGNET ENGAGES FLOOR BOARD CONTACTS, MAGNET ENERGIZED

Car Speed, Ft. Per Min.	Up Travel, Ft.-In.	Down Travel, Ft.-In.	Car Speed, Ft. Per Min.	Up Travel, Ft.-In.	Down Travel, Ft.-In.
800	17–0	18–0	600	10–8	11–4
750	15–4	16–0	550	9–8	10–0
700	13–7	14–4	500	8–8	9–0
650	12–0	12–8			





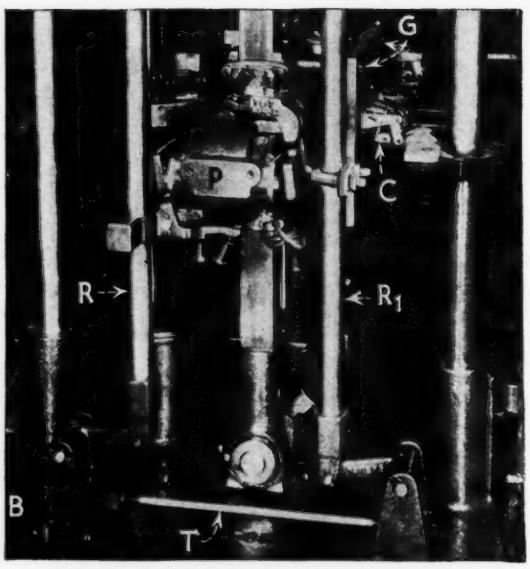


Fig. 5 (Top)—Brush magnet on selector crosshead

Fig. 6 (Center)—Brush magnet and floor-board contacts

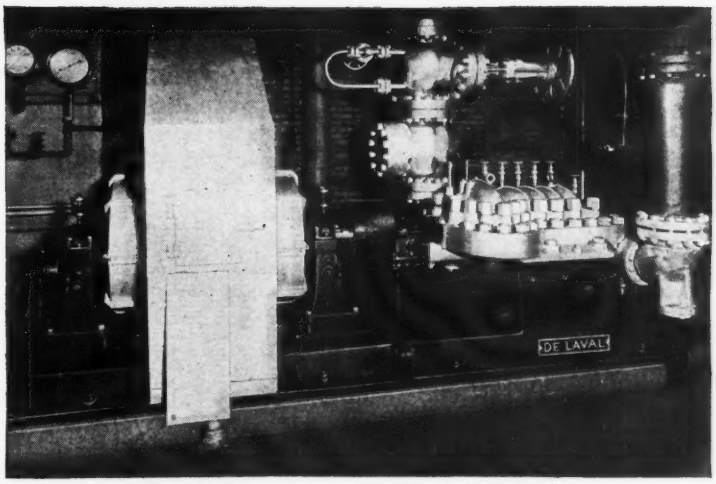
Fig. 7 (Bottom)—Bottom of the selector, showing how vertical U-bolt rods *R* and R_1 are connected

The floor stop contacts on the selector crosshead are carried on the brush magnet. There are two sets of these contacts, one for up motion and one for down motion and each is carried on an adjustable armature on the brush magnet *N*, Fig. 4. The general arrangement of the brush magnet and stopping contacts is shown in Fig. 6. Stopping operations in floor to floor travel is adjusted by screws *S* and S_1, for down motion. Similar adjustments are made on the top armature for up motion. This adjustment is independent of others, and will not be affected by them. The stroke of the magnet is adjusted by screws S_2, so that the car stopping contacts just make the corresponding floor board contacts when the car is a distance away from the floor shown in the table.

The contacts shown at *C*, Fig. 7, for illuminating the hall lanterns, the car position indicator and other signal devices are mounted on an insulating board. This board is slotted so that the contacts may be moved vertically to allow adjustment of each signal device to function at the proper time.

Judgment must be used in applying the instructions given in the foregoing. The settings suggested are for one type of control; adjustments for other types may vary slightly from those given. If the instructions are intelligently applied they will be of great assistance to elevator mechanics who have not had an opportunity to become entirely familiar with this equipment.

By A. PETERSON
Chief Engineer, Pump & Compressor Department De Laval Steam Turbine Company



Six-stage motor-driven boiler-feed pump operating at 3,500 r.p.m. and delivering 800 g.p.m. against 1,600-lb. per sq. in. pressure

EFFICIENT SUCTION HEAD FOR CENTRIFUGAL PUMP OPERATION

MANY of the troubles experienced in centrifugal-pump operation are attributable to unfavorable suction conditions. Either the suction lift is too high, the pressure on the suction of pumps handling hot or volatile liquids is insufficient, the pump's speed is too high, or the liquid has too great a velocity at the entrance to the impeller.

Understanding of this problem will be simplified if the words "suction" and "vacuum" are discarded and only absolute pressures above zero are considered. When a pump apparently lifts water by suction, actually the pressure exerted on the water by the atmosphere forces the water to the pump inlet. Some of this pressure must be left over at the entrance to the pump to have it operate satisfactorily.

In other words, in addition to lifting the water to the pump the pressure must be sufficient to overcome entrance losses and frictional resistance in the suction pipe and connections and to give the water the necessary velocity at the entrance to the pump impeller. After deducting the suction lift from the pressure (such as atmospheric) on the liquid's surface there must be a positive remainder. Moreover, this remainder should be increased with the water's temperature.

A positive excess of pressure is needed at the pump suction to supply a margin to cover inaccuracies in estimating the entrance loss, pipe friction, velocity head and total lift. It is also required to take care of the generally overlooked requirement of head to accelerate the water in the suction line when, on a boiler for instance, the feed valve suddenly opens, and to prevent formation of vapor or steam and the liberation of gases from the water. The latter would deprive the pump of the continuous column of liquid which it must have to produce pressure by centrifugal force. Bubbles of water vapor or the release of gases may cause rumbling in the pump and lead to rapid corrosion or pitting of the impeller and other parts.

Head required on the suction of centrifugal pumps for satisfactory operation at different water temperatures, such as found in boiler feed-water applications and hot-well service

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The pressure of saturated water vapor at various temperatures is shown by Fig. 2. The volume of water vapor which may be liberated depends upon the supply of heat, until all the water has been evaporated. To evaporate one per cent of the water will reduce the temperature, assuming that there is no external heat supply, approximately 11 deg. at around 212 deg. F. The volume occupied by the liberated water vapor will vary according to the specific volume of saturated steam at different temperatures. At 212 deg. liberation of water vapor from 1 cu.ft. of water, sufficient to cause a drop in temperature of only 1 deg., will release over 1.5 cu.ft. of vapor, which would be disastrous.

The amount of dissolved gas that may be released from the water depends upon the original gas content and upon the temperature and pressure. Water at 60 deg. F., under air at atmospheric pressure, will dissolve approximately two per cent of its volume of gas, the latter being measured at atmospheric pressure. The solubility varies directly as the pressure, so that under a reduced pressure some gas will be liberated. For example, if the pressure of the gases at the water's surface be reduced one-half, half of the gas will be set free.

It should be noted, however, that the pressure referred to is the partial pressure due to the gas under consideration, not the total pressure made up of the partial pressure of the gas plus the water-vapor pressure.

To illustrate, in the example just given, the gas is supposed to have been dissolved under atmospheric pressure, at 60 deg. F. At this temperature, the water-vapor pressure is around 0.5 in. mercury, or 0.25 lb. per sq.in. (see Fig. 2). Suppose that with the water remaining at the same temperature, the pressure is reduced to 1 in. of mercury, or approximately 0.5 lb. per sq.in. The water-vapor pressure will then be 0.5 in. of mercury, leaving the gas under a partial pressure of that value also. Under these conditions, the gas will be liberated until $\frac{1}{2} \div 30 = 1/60$ of the original amount remains in solution. The 59/60 liberated will, in company with water vapor, occupy a volume of:

$$0.02 \times \frac{59}{60} \times \frac{30}{0.5} = 1.18 \text{ times the volume of the water.}$$

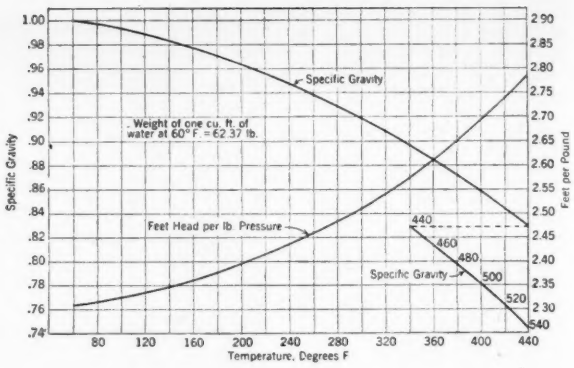
Therefore, in order to avoid the formation of bubbles of vapor and gas, or so-called "cavitation," it is necessary that at no point shall the total pressure be less than that of water-vapor corresponding to the temperature of the liquid. Also, some excess of pressure is required above that necessary to prevent dissolved gas from coming out of solution and interfering with pump operation. Liquids other than water, such as oils and gasoline, form vapors and may contain gas in solution which acts in the same way as do water-vapor and air. This to a degree, is determined by the properties of the particular liquid and gas.

When pumping water at 212 deg. F., as from open feed-water heaters under atmospheric pressure, it has been found that a properly designed and well-built centrifugal pump will operate satisfactorily if there be a gage pressure of 5 lb. (equivalent to $5 \times 2.41 = 12$-ft. head approximately) at the center line of the pump. In other words, a head of 12 ft. over and above the vapor pressure at 212 deg. F., of $14.7 + 5 = 19.7$ lb. absolute, is required.

This means that the center line of the pump must be located below the surface level of the water in the heater by a distance equal to 12 ft. plus the entrance losses in the pipe line leading from the heater, plus friction through the piping and valves between the heater and the pump, plus the velocity head required at the suction nozzle. With average conditions, the center line of the pump should be located at least 15 ft. below the water level in the heater; the velocity in the piping being not over 6 ft. per sec., and preferably less.

During recent years open or direct-contact heaters have been used as extraction feed-water heaters. The heater receives steam from a bleeder connection on the turbine, at pressures ranging both above and below atmospheric. Difficulties have, in some cases, been encountered with pumps taking water from such heaters. From the experience gained in pumping water at 212 deg., it might be concluded that 12-ft. head on the suction would be sufficient in all cases, even for a pump handling 400-deg water. The fallacy of this assumption is that, although 12 ft. may take care of accidental variations in pressure loss, it does not provide sufficient margin for temperature fluctuations at high pressures. This is because the difference in temperature of saturated steam corresponding to a given difference in pressure becomes less and less as the pressure is increased.

In a heater at atmopheric pressure and 212 deg., the net pressure at the suction nozzle of the pump under 12-ft. head is $14.7 + 5 = 19.7$ lb. absolute, which assures a 15-deg. temperature difference between the boiling point of 227 deg. and the actual water temperature of 212 deg. With this margin, satisfactory operation is generally obtained, since it is not probable that the temperature of the water will suddenly vary by as much as 15 deg.


Specific Gravity
Weight of one cu. ft. of water at 60° F. = 62.37 lb.
Feet Head per lb. Pressure
Specific Gravity
Temperature, Degrees F
Feet per Pound

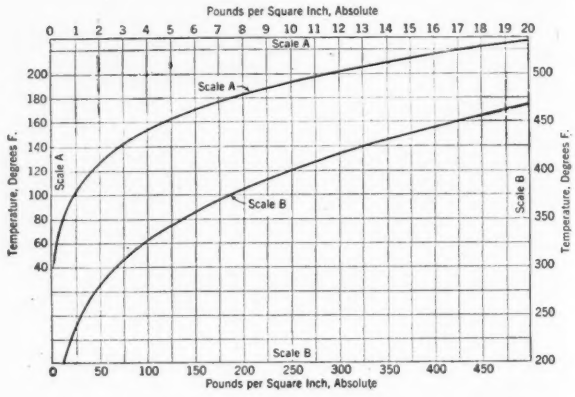


Fig. 1 (Above)—Specific gravity of water at various temperatures, with corresponding heads to produce a pressure of 1 lb. per sq.in.

Fig. 2—Temperatures of saturated water vapor at different absolute pressures

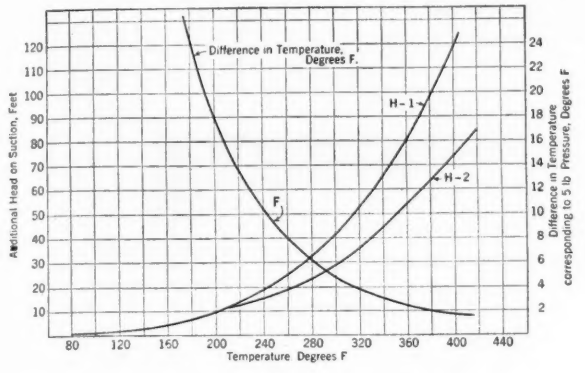
If the heater, however, be operated at a pressure of 250 lb. absolute, the temperature of the water will be 401.1 deg. With the pump placed far enough below the heater to give an absolute pressure at the suction nozzle of 255 lb., the temperature corresponding to that pressure will be only 402.7 deg. This leaves a difference between boiling point and the actual temperature of the liquid of only 1.6 deg., which is likely to be exceeded by the least disturbance in the operating cycle.

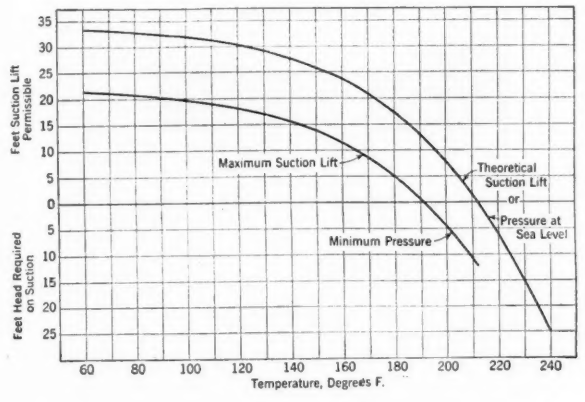
These disturbances may be caused by a reduction in load on the main unit, which would instantly reduce the pressure in the heater. They may also be caused by operating the pump at reduced capacity, which may result in raising the temperature of the water at the impeller's eye by the return of leak-off from the balancing device sufficiently to cause the water to flash. At light loads even the water leaking back through the wearing rings in the first stage may have a temperature high enough to flash when the temperature differential is small.

Although an excess pressure of 5 lb. is not sufficient at 400 deg., it is not necessary, however, to provide as great a difference in temperature between the actual temperature and the boiling point corresponding to the pressure as is required at 212 deg. A difference of 15 deg., corresponding to 12-ft. head at 212 deg., would correspond to a head on the suction of 121 ft. at 400 deg. This would not be practicable in most

installations, and experience shows it is not necessary.

While it is not easy to predetermine the minimum pressure difference required with higher temperatures, it is recommended that for high-speed boiler-feed pumps the temperature differential between the boiling point corresponding to the pressure and the actual temperature of the water should be not less than 10 deg. For a pump handling 400-deg. water this requires a suction head of about 75 ft. This would be difficult to obtain in many power plants, therefore it is better under such circumstances to have a slow-speed, single-stage pump discharge into the suction of the high-speed, multi-stage boiler-feed pump.




Feet Suction Lift Permissible
Feet Head Required on Suction
Maximum Suction Lift
Theoretical Suction Lift or Pressure at Sea Level
Minimum Pressure
Temperature, Degrees F.

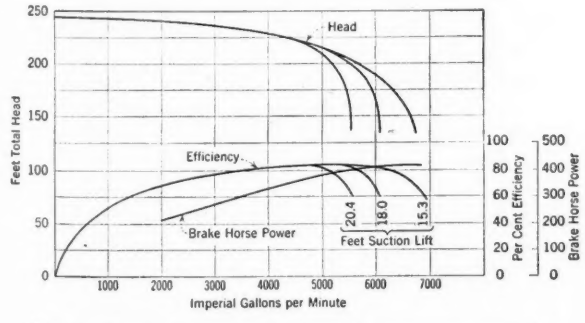


Fig. 3 (Top)—Increase in temperature corresponding to 5-lb. increase in pressure at various saturation temperatures; and heads required at the suction of centrifugal pumps

Fig. 4 (Middle)—Theoretical and practicable net suction lifts for water at various temperatures

Fig. 5—Characteristic curves showing test performance with various suction lifts of a 14-in. De Laval centrifugal pump for the City of Kingston, Ont.

▼

In Fig. 3, curve *H*-1 shows the head in feet required at the suction nozzle of the pump, corrected to the latter's center line, in order to have a difference between the boiling temperature corresponding to the pressure and the actual temperature of the water of 15 deg. F. for various water temperatures. Curve *H*-2 shows the suction head required to provide a temperature difference of 10 deg. F. with 400-deg. water temperature and gradually increasing temperature differences as the temperature of the water is reduced, up to 15 deg. at 212 deg. This curve is recommended for establishing minimum limits.

Curve *F* shows the difference in temperature between the boiling point corresponding to the pressure and the actual temperature required to provide 5 lb. excess pressure, at various temperatures. The danger of operating with low excess pressure at high temperatures will be seen from the fact that this curve approaches to within less than 2 deg. of the actual temperature at temperatures above 380 deg.

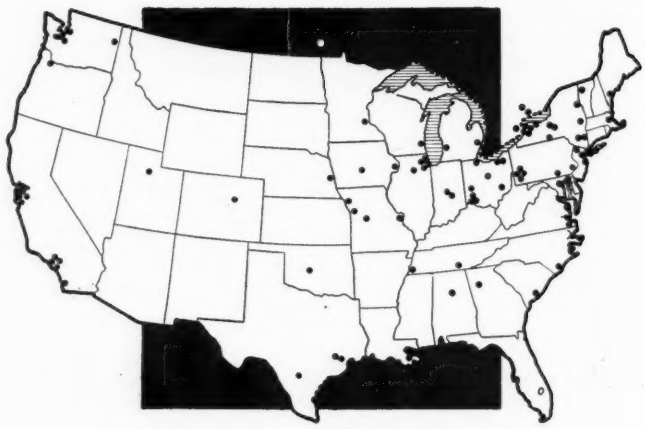
Curve *H*-1 also shows why it is that satisfactory operation is obtained with condensate pumps with comparatively low head on the suction. For instance, at a pressure of 0.5 lb. absolute, even with an 80-deg. temperature in the hot well, which corresponds to a vapor pressure at 0.5 lb., it should be possible to operate a pump with only 1-ft. head on the suction and still have 15-deg. temperature difference. It is not recommended, however, that condensate pumps be operated with so low a suction head, as other difficulties arise at such low pressures from the presence of gas other than water vapor. For this reason it is recommended that an actual head of 3 ft. be maintained on the suction of such pumps. By proper selection of the pump's size and speed satisfactory operation may be obtained with heads as low as 18 in. on the suction.

Where the pump is located above the water supply, so that there is suction lift, this lift, together with entrance loss, friction head and velocity head, should be subtracted from the pressure acting upon the surface of the water to obtain the net margin of positive absolute pressure acting on the suction. The upper curve, Fig. 4, shows the theoretical limit to suction lift, in feet of water, for various water temperatures at sea level. The lower curve gives the maximum recommended suction lift and minimum positive head required on the suction for higher temperatures. With water at 212 deg., a temperature difference of 15 deg. is provided between the boiling point and the actual temperature. Under a 20-ft. suction lift, with a water temperature of 95 deg., a difference of 77 deg. is provided to prevent gas being given off from solution in the water, as previously explained.

These charts should not be taken to mean that satisfactory operation of centrifugal pumps cannot be obtained at higher suction lifts. De Laval pumps have been in operation for a number of years designed for suction lifts as high as 28 ft., but great care is required in design, selection of speeds and determination of water velocities. The standard practice of practically all centrifugal builders is to base efficiency and capacity guarantees on 15-ft. dynamic suction lift, with 85-deg. water. Fig. 5 shows test characteristic curves, obtained with various suction lifts, of a 14-in. pump for Kingston, Ont.

NATIONAL BISCUIT SAVES POWER DOLLARS IN 85 PLANTS

By R. R. GALLOWAY
Manager of Engineering Department
and JOHN M. ACHESON
Engineering Analyst,
National Biscuit Company



Four-score widely flung plants, making everything from biscuits to machinery, present a wide variety of power problems. Coordinated control of power costs is saving this company a half-million dollars at a time when savings count

NATIONAL Biscuit Company owns and operates about 85 plants, varying greatly in size and in products—biscuits, bread, candy, ice-cream cones, paper, cartons, flour and machines. Problems confronting each plant are more or less individual, and a remedy for one may not be beneficial to another.

Location of factories all over the United States and Canada also tends to complicate any systematic control of similar functions in all plants.

In a number of places we produce all the power we use, in others we produce some and purchase a standby service from the local utility and in still others we purchase all of our electricity. However, even with the existing variety of problems with respect to goods manufactured, plant location and methods of obtaining power, we have succeeded in controlling power, light and heat expenses for all plants from the main office in New York.

The items classified as operating power, light and heat operating expenses for our factories are: (1) Coal for power plant, (2) Fuel oil for power plant, (3) Waste for power plant, (4) Packing for power plant, (5) Engine cylinder oil, (6) Ammonia-compressor cylinder oil, (7) Engine oil, (8) Boiler compound, (9) Labor, (10) Electric current purchased for power, (11) Electric current purchased for light, (12) Gas purchased for light, (13) Water for power plant, (14) Carting ashes and rubbish, (15) Ammonia, (16) Calcium chloride.

In addition to the above power plant expenses, we include in the Power, Light and Heat Account certain factory expenses: (17) Fuel for biscuit and bread ovens, (18) Water for factory, (19) Lubricating oils and grease for factory, (20) Oilers' salaries.

Every month, the manager of each plant submits a report to the engineering department, showing his monthly expense for each of the above items, as well as the quantity consumed. All items are tabulated on one side of a form sheet. On the reverse side of the form each manager submits supplementary information in reference to all items. For instance, he is required to record the average unit price of each item of power, light and heat expense for all purchases during the month under consideration.

He also records the following power-plant data: (1) Number hours service for power, lighting and heating; (2) Number hours service, additional, for fire pump and heating; (3) Average steam pressure during operation of factory; (4) Average steam pressure during nights, Sundays, and when factory is not in operation; (5) Weight of ash removed from ash-pits; (6) Average rated boiler capacity in service; (7) Average temperature of boiler feed water; (8) Average temperature of superheated steam; (9) Total water evaporated; (10) Average air pressure under fire; (11) Average draft over fire; (12) Average draft in boiler uptake; (13) Average flue gas temperature; (14) Average CO_2 in flue gases.

With the above data available each month, together with the record of the expenses and other office records such as production, kinds of goods manufactured, hours of oven operation, etc., the experienced engineer is

able to analyze the expenses from an efficiency standpoint and to make certain recommendations for improvements.

The first problem that naturally confronts anyone beginning a project of this kind is to standardize upon the method of reporting expenses. It is readily realized that where plants are widely scattered, a long period of instruction is necessary to attain standardized practice in reports.

High Costs Are Spotted

With the method of reporting expenses standardized, our next step was to obtain an average monthly expense for each item in each factory. Our basic figure was established on the 1930 record of each factory. With these values known, we were able to study them with respect to a theoretical cost, derived by means of the available power-plant and production data as previously outlined. Where the actual expenses were higher than the theoretical values, the methods used in that particular plant were studied and recommendations made which would tend to lower expenses.

Each P. L. & H. report received by the engineering department has each item of expense transferred to separate office records where it can be compared with the expenses for previous months since January, 1930. Knowing the theoretical amount for each item of expense, we are able to detect quickly all increases. Where they are not justified we so notify the manager.

Furthermore, we are able to show comparative figures for plants of similar size manufacturing the same kinds of goods. In this way we can explain to the manager, through the medium of bar-charts and tables, the effect of his uneconomical methods on his power, light and heat costs and also show him how his methods compare with those of other plants. Of course each manager strives to eliminate inefficient methods so that he may compare favorably with the others.

Our system of control has resulted in many ramifications requiring special study. For instance, the problems of collective buying of coal, boiler compound and other materials have been worked out to effect savings and to obtain more efficient methods.

Saving Money on Purchased Power

A feature of our system lies in the handling of purchases of electric energy for power and light and also gas.

The engineering department checks and approves all bills paid to utility companies. A record is kept of the amount of energy consumed each month, as well as its cost. Besides this record, a representative of the engineering department has visited the public service commissions in the capitals of the states in which our plants are located. From files there he was able to verify whether or not we were being billed under best available rates for gas and electricity. We have established a file in our own office of available rates in the localities where we have plants. By reference to that file we can tell at any time whether or not a cheaper rate is available.

As our studies progressed, we established a tack-chart as a reminder of the dates when our gas and electricity contracts expire.

Most utility companies require advance notice of any change that will affect a contract for gas or electricity, but the time required for the notice varies. Our tack-chart calls attention to the expiration date of each contract. Then the notification period is noted from each contract and a tack placed before the expiration of contract date, to represent the notification date. One month prior to the notification date tack, we place another tack, which indicates the review period.

During the review period, we study monthly consumption records in view of all available contracts to determine whether or not it would be more profitable to apply to the utility company for a different schedule. At least once a year, every gas and electric schedule is subjected to thorough study. These studies have proved extremely profitable.

One of the hardest things to control in plants where electricity is purchased for power and light is the demand charge. "Maximum demand" is generally caused by one or a few peaks due to an abnormal condition, often unnecessary. Many rates are so arranged that the consumer is billed for a year on the maximum demand registered during an abnormal period. Our company has felt the effect of this practice and is improving the demand situation greatly by the installation of equipment to eliminate all unnecessary peaks.

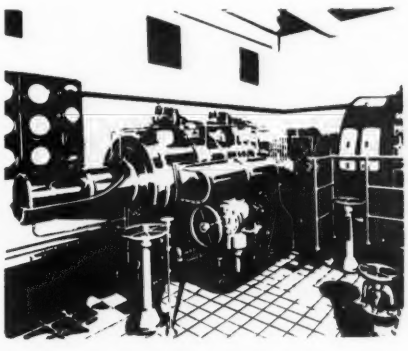
Another feature of our power, light and gas records is a bar-chart showing the unit cost of electricity and gas in all plants. Nearly all gas and electric rates are arranged so that the unit cost decreases with increasing consumption. To get a better comparison, we divided the plants into groups according to the amount consumed each month. The gas grouping was further subdivided into groups of plants burning manufactured and natural gas.

With all data available in reference to electricity and gas rates, we are able to decide quickly whether it is more profitable for us to shut down our own power plants and buy power or vice versa. We are also able to determine whether or not boilers and ovens can profitably be converted to gas-firing.

Our methods relative to gas and electricity contracts have saved many thousands of dollars yearly and have proved a tremendous aid in making engineering decisions.

Net Saving Over $500,000 Yearly

Studies of the various plants have resulted in engineering changes of almost every conceivable nature in these times when the resulting savings must justify the initial expense within a very short period of time. The 1931 P. L. & H. expenses were over a quarter million dollars lower than the 1930 expenses and the present rate of reductions for 1932 would indicate that they will be well over a half-million dollars under the 1930 figures. In other words, we are just beginning to benefit in 1932 by changes sponsored during 1930.



Our analytical department will continue to analyze the operating methods of each plant periodically so that advantages already gained will be maintained and further economies made wherever possible.

TESTING NON-CONDENSING TURBINES FOR EFFICIENCY

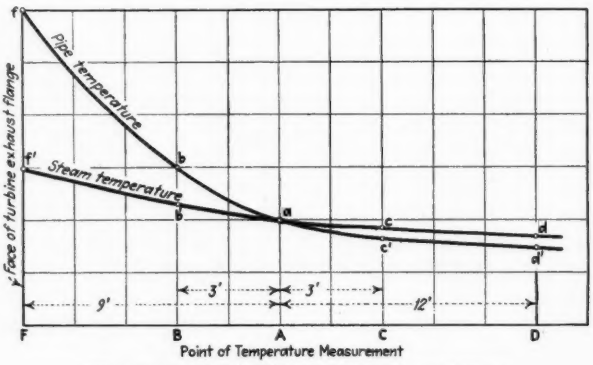
The simple method of testing here suggested is applicable whenever the enthalpy of the exhaust steam from the turbine can be determined

By GUY B. RANDALL
Superintendent of Power,
Champion Coated Paper Company

FOR many years the A.S.M.E. test code for steam turbines has been the general guide for determining turbine efficiencies. It has served in a substantial way to help place turbine performance guarantees on the high level of reliability which they now, in general, occupy. In order to determine turbine efficiency under a given set of conditions, the code calls, among other things, for five important determinations: Initial steam pressure, initial steam temperature or quality, exhaust steam pressure, power output (or energy output in a given time), rate of steam flow (or weight of steam passing in a given time).

The principal objection to this method of testing is the amount of work and expense involved in making an acceptable test. It is a method which requires extensive and precise knowledge of many factors in order to obtain trustworthy results. Where reserve equipment is severely limited, time itself becomes a rather formidable obstacle. Where a surface condenser is not available the difficulties are further increased.

It is in the face of conditions such as these that I have turned to a method of determining efficiency which for want of a better name I shall refer to as the heat input-output method. Thermodynamically speaking this method has long been known, but for reasons which will be given later it has been little used.



Measurement of exhaust steam temperature should be made at point indicated by *A*

The over-all efficiency of a turbine-generator may be expressed in the following manner:

Over-all efficiency = Internal efficiency × Rotational efficiency × Generator efficiency

The over-all efficiency may be referred to the total heat passing or it may be an efficiency ratio referred to the well-known Rankine cycle. In a given turbine-generator the actual figures may, for example, run about as follows: $0.85 \times 0.99 \times 0.97 = 0.82$ over-all efficiency ratio. The right-hand side of the equation represents the over-all efficiency ratio referred to the ideal turbine following the Rankine cycle as a reference base. The A.S.M.E. code refers to this specifically as the "engine efficiency," also known as the over-all efficiency ratio.

Rotational efficiency will usually run within a few points of 100 per cent; the generator efficiency is well above 90 even in small generators. The former can, with all required accuracy, be estimated by formulas. The latter can be found from no-load and short-circuit tests.

In the equation given, the internal efficiency is 85 per cent. In cheap and in old turbines, efficiencies of half this value are not uncommon. If, then, the internal efficiency is capable of easy and reliable determination, we have available an important method not only for verifying the builder's guarantee but for keeping check on month-to-month condition. The determination of the internal efficiency ratio involves only these four accurate measurements: (1) initial pressure, (2) initial condition, (3) final pressure, (4) final condition.

If entering and leaving steam are superheated, the determination of the internal efficiency reduces to four comparatively simple measurements, namely, two pressures and two temperatures. Since two pressures and one temperature determination are required under the code method of testing, this leaves only one temperature determination to balance against two relatively difficult code measurement, namely, power output and steam flow or steam weight. Where the two temperature determinations are made by calibrated thermocouples and a sensitive (precision type) potentiometer, a high degree of accuracy is obtainable.

This method of determining temperature is much simpler, more practical, and more reliable, all things considered, than mercury-in-glass thermometers. It is hardly an exaggeration to say that they are the most intricate instruments one has to use in commercial power plant testing, as their apparent simplicity leads to a certain amount of subtle confusion.

As an example, suppose it is desired to determine the

internal efficiency of a 7,500-kw. turbine-generator taking steam at 600 lb. absolute, 780 deg. F., and exhausting at 140 lb. absolute, 480 deg. F. A portable precision-type potentiometer and a pair of calibrated iron-constantan thermocouples would enable temperature measurements to be taken with an accuracy of plus or minus 1 deg. The principal precautions to be observed are:

1. The thermocouple should be in contact with a representative sample of the steam whose temperature is desired.

2. The insulated lead wires should be wrapped around the pipe or extended along the pipe under the heat insulation for two or three feet practically to eliminate cooling of the hot junction by conduction.

3. The thermocouple leads or the well (if used) should be heat insulated from the pipe wall where the leads pass through the wall.

4. Necessary precautions should be taken to prevent the thermocouple bead or thermocouple well from "seeing" at close range a materially hotter or cooler object than the steam whose temperature is desired.

5. If a good many readings are to be taken, a couple of reading glasses will magnify the galvanometer needle and the scale of the potentiometer and help to make balancing and reading easy on the eyes.

It will be noted that of these five precautions, four would apply with equal force to a mercury thermometer measurement, while Precaution No. 2 is much easier than a stem correction. With measurements taken as herein indicated, an over-all accuracy within 2 deg. F is obtainable at both turbine inlet and exhaust.

Having obtained the four requisite readings, internal efficiency can be easily calculated on the basis of the Keenan steam tables as follows:

	B.t.u.
Enthalpy at 600 lb. absolute, 780 deg. F., 1.6268 S	1,397.8
Enthalpy after isentropic expansion to 140 lb. absolute, 428.5 deg. F.	1,236.3
Heat theoretically available	161.5
Enthalpy at 600 lb. absolute, 780 deg. F	1,397.8
Enthalpy of steam actually discharged at 140 lb. absolute, 480 deg. F.	1,263.7
Heat actually available	134.1

Internal efficiency ratio

$$= (134.1 \div 161.5) \times 100 = 83.0 \text{ per cent.}$$

Now let it be assumed that all measurements are correct except that there is a 2-deg. error made in determining the initial temperature. The incorrect efficiency then becomes 83.0 per cent plus or minus 0.7 per cent. If the temperature were *high* by 2 deg. the efficiency is thus *increased* by $(0.7 \div 83.0) \times 100 = 0.8$ per cent. Again, if the only error is a 2-deg. inaccuracy in the exhaust temperature, the corresponding incorrect efficiency becomes 83.0 per cent plus or minus 0.6 per cent. If the temperature were *high* by 2 deg. the efficiency is *decreased* by $(0.6 \div 83.0) \times 100 = 0.7$ per cent.

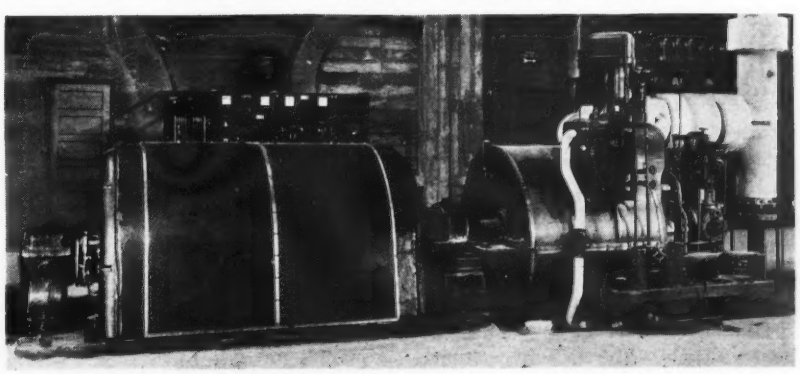
Apparently the principal reason why the heat input-output method of testing has not received the recognition and application it would seem to deserve is that condensing turbines almost invariably have wet steam at the exhaust, and until comparatively recently non-condensing turbines were so small that no one paid much attention to their efficiencies. Measuring the moisture content of wet steam at the immediate tail-end of a condensing turbine by the methods available is not unlike trying to determine the rainfall with a tin cup placed near the vortex of a baby tornado. Of course, a correct pressure determination in this case is not altogether easy either. Where the turbine discharges to a process steam line so that measurements may be made further from the turbine, a wetness determination becomes less difficult. When the steam is superheated, a condition becoming increasingly common, the matter becomes comparatively easy. But two special precautions are necessary in order to obtain the correct temperature.

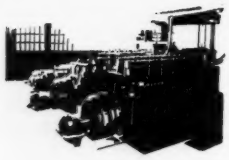
Steam expanding through a turbine has a comparatively large temperature drop in a relatively short axial distance. The turbine casing is thick and as a result heat flows through the metal of the casing by conduction from the hot end to the cold end of the turbine thus giving a wall temperature at the turbine exhaust flange that may be many degrees hotter than the adjacent steam. Care must then be exercised in taking temperatures at or near a turbine exhaust to be sure that the temperature of the steam and not the temperature of the pipe or other radiated temperature is the one measured.

To be safe, it is desirable to make temperature measurements several diameters of the turbine exhaust away from the exhaust flange and preferably after going around an elbow or two. If this cannot be done, some method of shielding is required. Where an elbow intervenes, practically all radiation is absorbed by the elbow, which is practically a black body. Aside from the radiation effect, the accompanying curve (not to scale) indicates where the exhaust temperature can be taken with the least error. The curve is self-explanatory and point *A* or its immediate vicinity is obviously the best place because pipe wall temperature and steam temperature are identical.

Little has been said about the determination of internal efficiencies when steam at the turbine exhaust is wet. Even here the obstacles are not insurmountable, if the measurements are made a few diameters away from the exhaust flange. In the past six or seven years considerable progress has been made toward more accurate determination of the quality of wet steam, particularly as to sampling both in the range of the ordinary throttling calorimeter and in that wetter field where electricity must be used to dry the steam or a separating calorimeter used. It may, however, be better to limit the heat input-output method for the immediate future to installations when the exhaust steam is superheated. With this limitation the test method would appear to constitute a worthwhile revision and enlargement to the code.

Steam turbo-electric generators like this Emeryville, Calif., unit are regularly subjected to test control





GAS POWER

SUPPLEMENTS HYDRO IN PUMPED-STORAGE PLANT

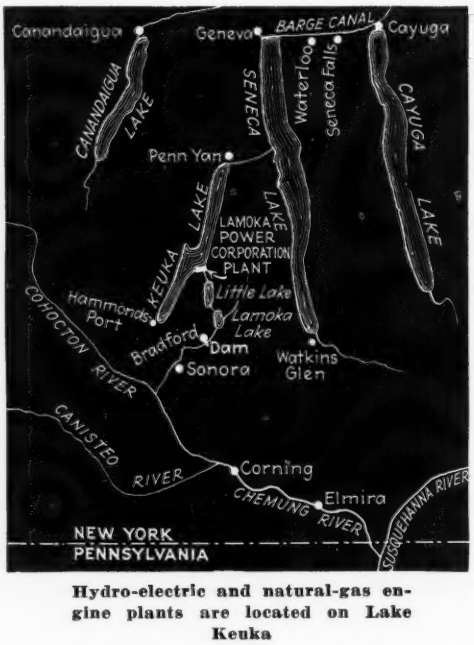
On Lake Keuka in New York State the Lamoka Power Corporation is building a combination gas-engine and pumped-storage hydro-electric plant. During off-peak periods the gas-engine-driven generators will supply power to pump water into the hydro plant's reservoir. When peak load occurs the gas-engine and hydro plants will operate in parallel to supply the demand

PUMPED-STORAGE hydro-electric plants are used extensively in Europe, over 40 such projects being in operation, some of them designed for large capacities. In the United States only one important plant of this type, the Rocky River station of the Connecticut Light & Power Company, has been put into service. The initial installation of a second pump-storage plant is now under construction on Lake Keuka near Bradford, N. Y. This plant is unique in that gas-engine-driven electric generators operating on gas taken out of the ground near the hydro plant will be used to supply the power for pumping.

75-Year-Old Plant

Little and Lamoka Lakes are 389 ft. above Keuka Lake. A dam has existed at Bradford for 75 years and has kept the lake's surface at an elevation approximately 1,100 ft. above sea level. Power was generated at the dam for grinding grists of farmers, utilizing a head of about 15 ft. This water flowed southward into the Cohocton River, which discharges into the Susquehanna River, as shown on the map.

Through an act of the New York State legislature of 1918 authority was given the Lamoka Electric Water-Power Corporation, now owned by the Lamoka Power Corporation, to divert the water of Little and Lamoka lakes northward into Lake Keuka. From the latter it would flow into Seneca Lake and into the Barge Canal owned and operated by New York State.

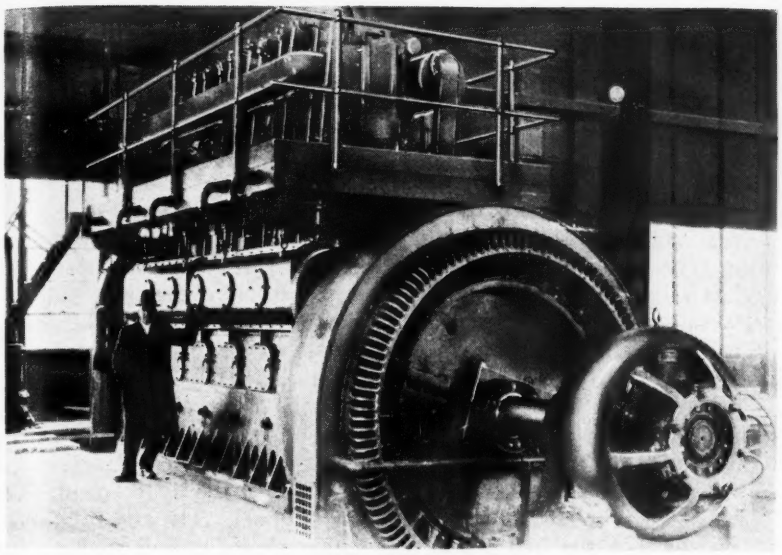


Hydro-electric and natural-gas engine plants are located on Lake Keuka

Every few years the canal's operation has been restricted because of a water shortage which, it was decided, could be alleviated by the added water supply. The Lamoka company was also given authority to utilize the water for power generation in a plant on Keuka Lake. In 1929 the first hydro-electric unit of 2,000-kw. capacity began operating at the Lake Keuka plant.

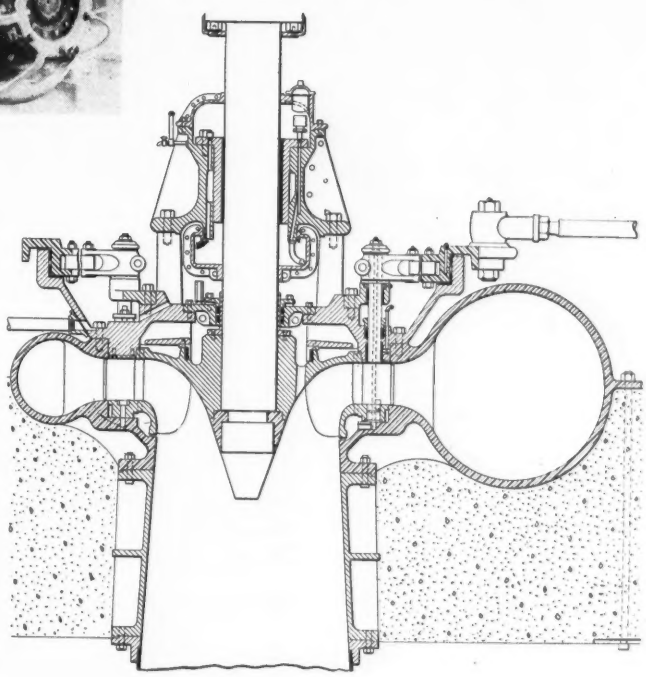
Plans were made to use the flood waters of the Cohocton River, the use of which had also been granted to the electric company. These plans called for a dam 1,200 ft. long at Sonora, to flood the valley back to Bradford. This would create a new lake about eight miles long, which, added to Little and Lamoka Lakes, would form a reservoir 14 miles in length. A canal, 11 miles long, was contemplated, to bring the water of the Cohocton River to the reservoir, it being intended to pump from the Canal to the reservoir. This project would have required an investment of $2,500,000.

About the time the 2,000-kw. unit began operation a



Vertical, 1,200-hp. 6-cyl., 4-cycle gas engine operated on sweet natural gas and driving an 800-kw. alternating-current generator

Section through a 7,500-hp. hydraulic turbine to operate under a 385-ft. effective head. The runner will be of bronze and the scroll case a one-piece steel casting



well of sweet natural gas was brought in near the company's property. This well was purchased by the Lamoka company. Drilling was then started by the company on its own lands. Some of the largest sweet-gas wells in the state were brought in, one of them gaging more than 13,000,000 cu.ft. per day.

Manufacturers of gas engines were approached on the possibilities of generating electric power from natural gas. The result has been that, instead of spending $2,500,000 on canals, dams and other works to utilize the flood waters of the Cohocton River, the same result measured in kilowatt-hours is to be obtained by an investment of about $500,000.

Thus, there is to be established a unique combination for power development: a hydro-electric station to produce power under a net head of 385 ft., and additional power from a vast store of natural gas 1,750 ft. below the surface of the same lands. There are other power plants using combinations of prime movers, but it is believed that this is the only generating station where these two natural resources, water and natural gas, from the same land are used in a joint station.

Gas-Engine Power Plant

After exhaustive investigation by engineers it was decided to install a gas-engine generating plant having a capacity of at least 10,000 hp. The first unit of 1,200 hp., now in operation, is of the Rathbun Jones type supplied by the Ingersoll-Rand Company. It is a six-cylinder four-cycle vertical unit—the largest vertical gas engine in operation in this country.

The engine is directly connected to an 800-kw. General Electric generator designed to operate in parallel with the hydro-electric units. As part of the auxiliary equipment there is an air compressor of ample capacity to take care of starting the engine, to supply all air tools and the air-operated 15-ton crane.

The final plans embody another 1,200-hp. unit and three of 1,800-hp. capacity. The three 1,800-hp. engines are now being built by the Worthington Pump and Machinery Corporation. These engines, which will operate at 225 r.p.m., are of the four-cycle vertical type. Each unit will consist of two 6-cyl. engines with a 1,250-kw. General Electric generator and a flywheel between.

This project is designed to supply peak-load capacity on a large system, the combined capacity of the gas-engine and hydro plants being available for peak load service. When the demand decreases the power generated by gas will be used by large motor-driven pumps, which will deliver water from Keuka Lake to Lamoka reservoir. Pumping will be done during off-peak hours, including Sundays. By this means the water storage will be kept constant, being renewed daily, to supply the hydro-electric plant during peak loads.

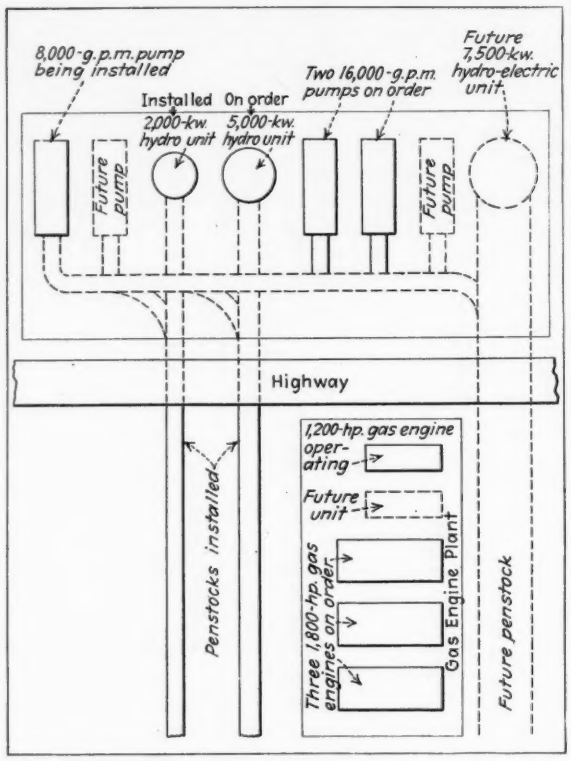
Plans are to install two 8,000-g.p.m. and three 16,000-g.p.m. pumps. One 16-in. Ingersoll-Rand pump consisting of two double-suction units in series to deliver 8,000-g.p.m. against a head of 398 ft., is now being installed. The pump is driven by a 1,000-hp. induction motor operating at 1,150 r.p.m. The Worthington Company is also building two 24-in. double-suction volute pumps, each to deliver 16,000 g.p.m. against a 398-ft. head, and driven by 2,000-hp. General Electric synchronous motors.

The turbine to be installed in the hydro plant is being built by James Leffel & Company. It is of the vertical-shaft type rated at 7,500 hp. under a 385 ft. effective head and will run at 600 r.p.m. This new unit is to be installed in an extension to the existing power house in

which a 2,000-kw. vertical-shaft machine is now operating. It is planned ultimately to further extend the plant and to install a unit of 10,000-hp. capacity. The 7,500-hp. turbine will have a solid-bronze runner with a specific speed of about 30 and drive a 5,000-kw. Electric Machinery Manufacturing Company generator. A cast-steel scroll case is used, cast in one piece.

The diameter of the scroll case inlet is 42 in. The inlet can be closed with a motor-operated valve. A draft tube of the plate-steel straight-conical-flaring type is used. To insure that the tube will be sealed at all times its lower end is placed five feet below low tail-water level. The upper end of the draft tube is formed by a heavy steel casting which extends downward past the region of the highest water velocity.

The wicket gates are of cast steel with stems integral and are equipped with special patented seal rings on the lower end to prevent undue upward water thrust



General plan of equipment of hydro-electric and gas engine plants

on the gate, this being a feature that has proved successful in this type of installation. The gate operating mechanism is of the exposed type, grease lubricated through Alemite connections. Each gate stem is supported in three bronze bearings, is drilled through its entire length so as to force grease to the bottom bearing and is suspended on a ball bearing from the underside of the lever.

So that close clearances can be maintained, renewable steel wearing rings are provided on the hub and band of the runner adjacent to the crown plate and bottom plate. Also the crown plate next to the gates is faced with renewable bronze lining and the bottom plate is a bronze ring, which can be renewed in the future if necessary. Thus provision is made to maintain the initial high efficiency of the turbine. The main shaft bearing is of the babbitted oil-lubricated type; oil distribution is obtained by means of centrifugal action.

A 15-in.-diameter relief valve will be connected to the gate-operating mechanism to move synchronously with the governor. It is designed to open when the turbine gates close. In this way pressure rises in the mile-long penstock will be prevented. The relief valve will connect to a neck cast as part of the scroll case.

The speed of the turbine will be regulated by means of a Woodward oil-pressure governor of the latest type with motor-driven governor head and pump.

Since July 1, 1931, a new concrete dam has been constructed at Bradford, with steel overflow gates, concrete headworks installed at elevation 1,102. A new penstock has been constructed from the reservoir to the power house to operate the 7,500-hp. turbine now on order. A building to house gas engines and generators is on the opposite side of the road from the hydro plant, and is connected to the latter by a tunnel. The general layout of the hydro and gas-engine plants is indicated in the diagram on the left.

▼ ▼ ▼

Utility Man Discusses Industrial Plant Competition

POWER men—both utility and industrial—will be interested in the following comments abstracted from a paper by Arthur E. Silver of the Electric Bond & Share Co. Mr. Silver was addressing the Engineering Section of the N.E.L.A. (Atlantic City Convention, June 7, 1932).

"A keen competitor of central station industrial power is the diesel engine, under the present very low prices for engine fuel. Diesel engine designers have been alert to their opportunties—much more so, I believe, than the engineers of our industry generally realize. The last few years especially have brought marked improvement in materials and design, with greater reliability in operation, high efficiency, higher speeds and lighter weights.

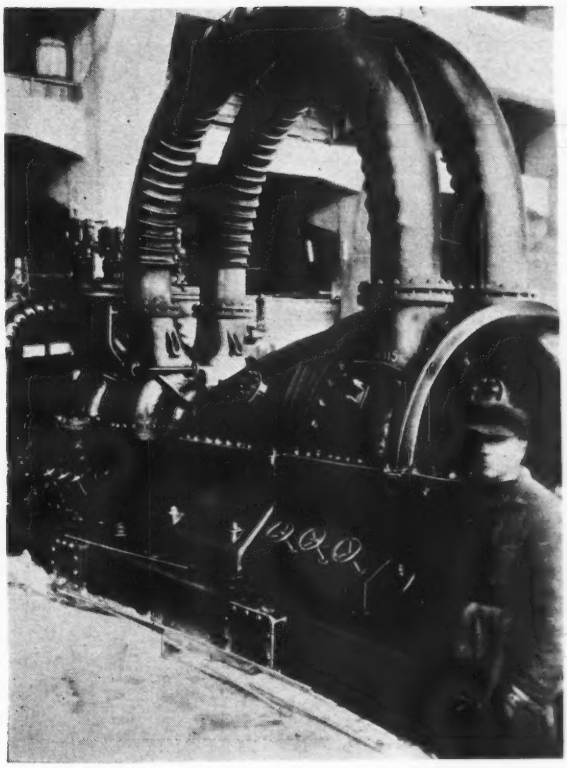
"In meeting this competition, a new order of analysis and comparison must be applied. Alert, competent engineering aid is needed by the commercial and industrial departments of the power company.

"If it is found that in some situations, the diesel engine shows economies superior to those from conventional power system service, then the ingenuity of our engineers should be called upon to apply this advantage in some manner as a central station function. Service from the diesel engine as a central-station adjunct should have advantages over completely isolated service.

"Fully as keen competition is being pressed in some of the larger energy consuming industries by the availability of low-cost high-pressure steam equipment that may be used to supply process steam for industrial use, with electrical energy as a by-product. In addition, some of these industries produce by-product heat or by-product fuel. Such competition requires a careful analysis of the industrial operations, comparing central station supply with an isolated plant, determining the most economical method for the industrial of serving the combined requirements for electrical energy and process steam or, on the other hand, of utilizing the by-product heat or fuel.

By FRED N. HAYS

5 Great Power Plants Rise at Magnitogorsk



Each turbine-driven blower delivers 115,600 c.f.m.

One of the world's greatest metallurgical projects, nearing completion in the wilds of Siberia, will feed 2,500,000 tons of iron and steel yearly into the shops and factories of Soviet Russia. Its five power plants, two for furnace blowing and three for electricity, will have a combined equivalent capacity of 632,000 kilowatts

POWER, iron and steel—the basic industrial commodities—are the foundation stones of the Soviet five-year plan. Power is typified by the enormous hydro-electric development at Dnieperstroy; iron and steel by the mines and metallurgical plant at Magnitogorsk. The latter also is a great power project. In both American engineers played an outstanding rôle.

Magnitogorsk, in a corner of Siberia about 1,200 miles east of Moscow, takes its name from the hills of rich magnetic iron ore which have already drawn 200,000 men, women and children to this isolated spot.

The desire to give Russia the most advanced thought and equipment for the gigantic project at Magnitogorsk has inspired its engineers in the design and construction of its power plants. In America our engineers have attempted to approach central station design in steel-plant power houses, but have sacrificed the more efficient heat cycles for the sake of simplicity and flexibility. Should the blast-furnace power houses at Magnitogorsk be able to maintain reliable and continuous operation, an advance will have been made.

The metallurgical plant at Magnitogorsk will have eight large blast furnaces which will produce annually 2,500,000 tons of iron. Two furnaces, the largest in Europe, are now in operation. To serve these eight furnaces two blowing-engine power houses are being built. In addition there will ultimately be three central plants for the generation of electricity, giving a grand total of 632,000 kw. equivalent capacity in five plants.

The two blast-furnace power houses are essentially duplicates. Each is built for operating with four furnaces and contains the necessary boilers, turbine blowers and their auxiliaries.

Three Dürrwerke (German) boilers are installed in blast-furnace power house No. 1. Two types of blowers, Gutehoffnung Hütte and Brown Boveri, are used in the first station, which contains five blowers. Normal operation will be by two boilers and four blowers.

The Dürrwerke boilers are of the vertical water-tube type having three passes. Walls and floor are water-cooled; firing is tangential from the four corners. The superheaters are of the convection type. Forced- and induced-draft fans are used and all boilers are equipped with plate-type air preheaters. Pulverized coal, blast-furnace gas and coke-oven gas can be fired separately or in combination.

The average output of each boiler will be 230,000 lb. of steam per hour at 425-lb. pressure and a temperature

of 800 deg. F. Water-heating surface per boiler (exclusive of water walls) is 18,123 sq.ft. The effective water surface of walls and floor is 3,660 sq.ft., superheater surface 11,174 sq.ft. and air-preheater plate surface 7,650 sq.ft. With furnace volumes of approximately 23,200 cu.ft. per unit, the boilers will normally be operated at 450 per cent of rating, liberating 14,800 B.t.u. per cu.ft. of combustion space per hour. The net fuel consumed for blowing will amount to 14,600,000 B.t.u. per blast unit.

Burn Gas and Pulverized Coal

The gas balance of the combined metallurgical and chemical plants indicates that ordinarily the fuel at the boilers will be 60 per cent pulverized coal, 20 per cent blast-furnace gas and 20 per cent coke-oven gas. With this fuel combination the manufacturer guarantees 83 per cent efficiency at 450 per cent of rating.

Boiler coal is transported from Kuznetz or Cheliabinsk; Kuznetz is 1,300 miles distant and Cheliabinsk about 400 miles. The better grade of coal has a heating value of about 12,200 B.t.u. per lb., an ash content of about 9 per cent and is fairly high in volatile. The powdered-coal system is of German manufacture and is of the direct-fired type. Ash is removed from the ash-pits by a hydraulic conveyor and fly ash by a centrifuge ahead of the stack.

Boiler auxiliaries are all of German design and manufacture. Boiler feed pumps of both steam and electric drive have been provided. Evaporators are used to generate steam from chemically treated water to supply the demands of 160-lb. pressure steam. A regenerative cycle is used, steam being extracted from both the turbine blowers and a house turbine of 6,000-kw. capacity. The boilers will evaporate condensate returned at a temperature of about 315 deg. F.

The blast-furnace power houses have a splendid layout; the buildings are made of concrete block, are well lighted and of ample size. Each is made up of three sections. The middle is a narrow high section which houses the boiler-feed pumps, boiler, blower and generator control, heat-transfer equipment, boiler forced- and induced-draft fans, surge tanks, etc.

On one side of this central section is the turbine room with its turbine blowers, motor generators and turbine generator. On the other is the boiler room, complete with boilers and pulverized-coal equipment. This arrangement is very convenient for operating; all major equipment is in plain view of the control panels, closely coordinating the boiler- and turbine-room operation. The blast-furnace power houses are modelled from central electric station No. 1 (capacity 344,000 kw.)

The turbine room of each blast-furnace boiler house contains five turbine blowers, a house turbine generator and a pair of motor generators. Normal load capacity of each blower is 6,300 kw. and the maximum 9,000 kw. Characteristics of the blowers are:

Air supply (cu.ft. per min. at 60 deg. F. and 30-in. Hg.)	93,200	115,600	65,200	42,800	84,200
Air pressure (lb. per sq.in. gage)	22.8	25.6	35.6	7.8	34.2
R.p.m.	3,800	3,100	3,200	2,250	3,000
Capacity in kilowatts	6,300	9,000	7,000	2,900	8,000
Steam consumption (lb. per hour)	54,900	84,300	55,000	43,000	85,800

Blower turbines are equipped with one bleeder connection for heating the condensate from 86 deg. F. to 203 deg. At normal load the pressure at the bleeder will be 10.5 lb. with an extraction of 5,000 lb. of steam per hour, heating the condensate (54,000 lb.) to 185 deg. Further heating up to 203 deg. is effected by an additional bleeder regulated by hand. Water for the condensers is pumped directly from a large artificial lake at an average yearly temperature of 55 deg. F. The condensers are of two-pass design with a tube cooling surface of 5,600 sq.ft.

The house turbine for No. 1 blast-furnace power house will have a capacity of 6,000 kw., and a large quantity of steam will be bled at a pressure of 227 lb. At normal loads the turbine will have a Rankine-cycle efficiency of 72 per cent.

Four Russian-built boilers, having a water-tube surface of 16,000 sq.ft. each, will be installed in the second blast-furnace power house. Each boiler will normally be operated to furnish 190,000 lb. of steam per hour. Three boilers will be operated, with one as a spare. The heat cycle has been somewhat modified from that of No. 1 station, but is regenerative. The house turbine will be of 12,000-kw. capacity, and steam will be extracted at 57 lb. pressure for plant heating purposes.

In addition to the two blast-furnace power houses, the metallurgical plant will secure steam, amounting to 200,000 lb. per hour at 160 lb. and 410 deg. F., from waste-heat boilers on 42 open-hearth and 29 pit furnaces.

It is estimated the combined metallurgical and chemical plants at Magnitogorsk will require about 1,500,000 tons of boiler coal per year. The cost of coal as delivered on the plant varies from 19 to 25 rubles ($9.50 to $12.50) per ton. With the high cost of fuel, steam will probably cost from $0.50 to $0.70 per 1,000 lb.

Three Central Stations Total 542,000 Kw.

The combined mining and metallurgical plants and industrial city will be served by three main central electric plants. The first, now partially completed and in operation, will have a generating capacity of 344,000 kw. The second station is being designed primarily for steam extraction to heat water to be used in the radiators of the Soviet town of 200,000 inhabitants. It will have a capacity of about 48,000 kw. The winter heating load extends over a period of seven months with an outside temperature varying from 40 deg. F. above to 40 deg. below zero.

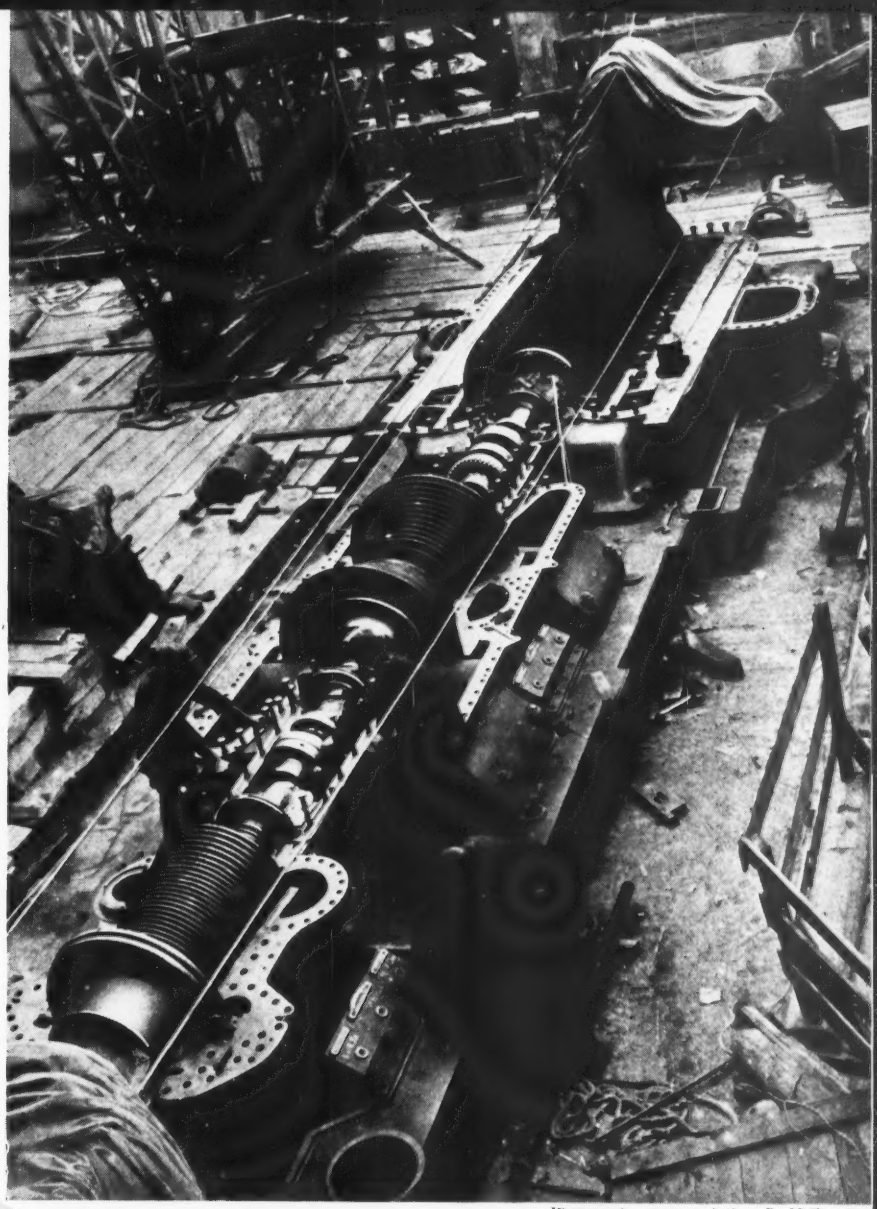
The third station will be designed primarily for the chemical plant and will probably have a capacity of 150,000 kw. The principal departments of the chemical plant, in addition to the coke and byproduct works, will be synthetic ammonia, fertilizer and tar distillation.

Steam generating equipment in No. 1 central electric station is almost identical with that described in No. 1 blast-furnace power house. The generating capacity is made up of 12,000-, 20,000- and 50,000-kw. turbine generators. At normal load each 50,000-kw. unit will consume 15,000 B.t.u. in fuel per kw.-hr.

The building of No. 1 blast-furnace power house and No. 1 central electric plant was carried on while the writer was in Magnitogorsk. The work was well supervised, but much had to be removed and rebuilt due to the inexperience of the workers. Power-house construction was pushed in order that no delay would be encountered in starting up the first blast furnace. This, together with delayed materials, caused the installation of temporary equipment and hookups which were not conducive to the most efficient or safe operation.

An American firm, Arthur G. McKee & Company, Cleveland, Ohio, prepared the general plans for the Magnitogorsk plant and mines and supervised the first two years of construction.

542,000 KW. for SOVIET STEEL

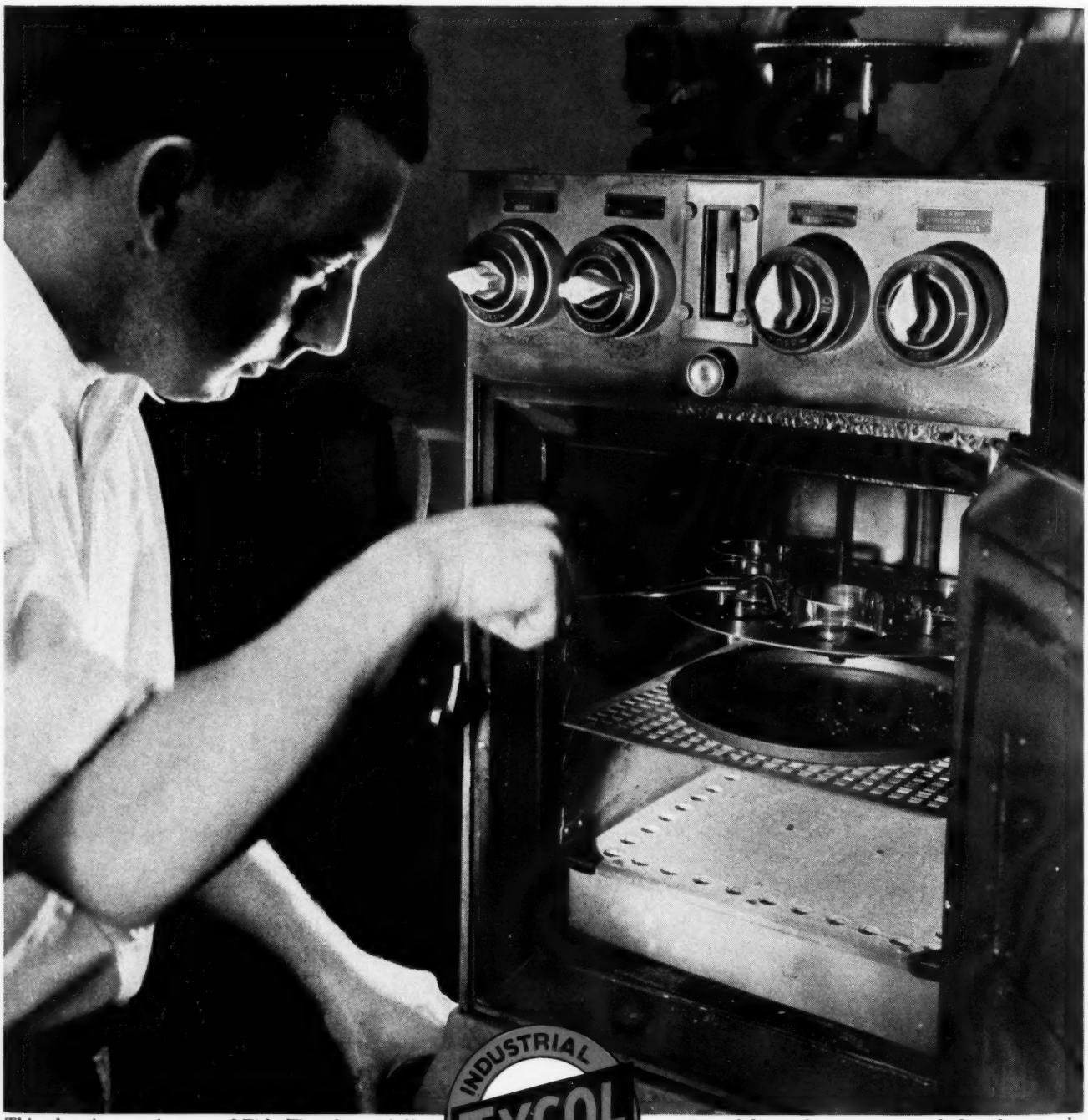


Photographs courtesy Arthur G. McKee & C

IN RUSSIA TODAY, MAGNITOGORSK IS THE SYMBOL OF IRON AND STEEL. HERE IN THE URAL WILDERNESS HAVE SPRUNG UP IRON MINES, BLAST FURNACES, ROLLING MILLS AND A CITY OF 200,000 WORKERS. POWER AGGREGATING 542,000 KW. WILL BE PROVIDED BY THREE CENTRAL PLANTS. NUMBER 1, SHOWN AT LEFT UNDER CONSTRUCTION, IS NOW CARRYING LOAD AND WILL HAVE AN ULTIMATE CAPACITY OF 350,000 KW. ABOVE IS ONE OF THE TEN (ULTIMATE) TURBINE-DRIVEN BLOWERS HOUSED IN TWO BLAST FURNACE BLOWING PLANTS. THEIR COMBINED CAPACITY WILL BE 1,115,000 CU.FT. PER MIN.

TIDE WATER RE-*refines*

TYCOL SHOWN TO HAVE



This electric oven is part of Tide Water's specially-devised method of determining oxidation number. It is more rigid than the usual test . . . forces thorough mixing of the oxidizing agents with the oils . . . results in more exact data. All the oxidation numbers given in the text were arrived at by this method.

INDUSTRIAL TYCOL OILS-GREASES

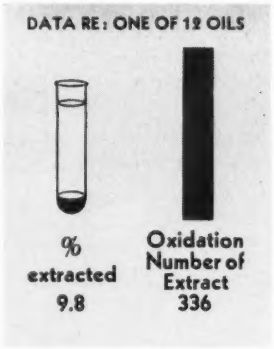
TIDE WATER

12 *Competitive Oils*

LOWER OXIDATION NUMBER*

Usual refining methods leave 12 leading turbine and Diesel oils with average Oxidation Number of 43; average drops to 5 when oils are RE-refined

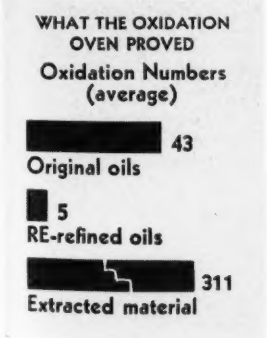
A turbine or Diesel lubricating oil has high or low oxidation number, depending on the refining. To prove this, Tide Water bought 12 competitive brands of finished turbine and Diesel oils in the open market . . . and re-refined them by Tide Water's Special Edeleanu Process. The original oxidation number of two-thirds of these oils was over 26 ...one-third of them, over 68...one as high as 194! Average 43. Re-refining lowered the average to 5!



Furthermore, each of these oils yielded extracts with oxidation numbers as high as 399... and averaging 16% of volume. These impurities are the causes of carbon, acidity, sludge and oil break-down.

BETTER REFINING GIVES GREATER STABILITY ... Here is clear proof that Tide Water's Process does what ordinary refining methods fail to do . . . it refines an oil that is non-sludging, low in oxidation number, and high in stability.

Here are the reasons: The Process is a physical solvent treatment. It dissolves ALL unstable hydrocarbons, found even in the best of crudes. It starts NO chemical reaction upon the components of oil, stable or unstable. It forms NO new unstable substances. And it preserves the pure and stable hydrocarbons of highest lubricating value.



That is why Tycol Turbine and Diesel Oils, being 100% paraffine base, and refined by this Process, have purity and stability which no other oils possess. Tycol Oils have oxidation numbers ranging from 1/4 to 1/50 of those of competitive grades.

TYCOL'S SERVICE RECORD IS PROOF . . . In the final analysis, it is service that counts. Everything shown in these laboratory tests is borne out in experience. Tycol oils have set up new records of performance for some of the country's leading producers of power.

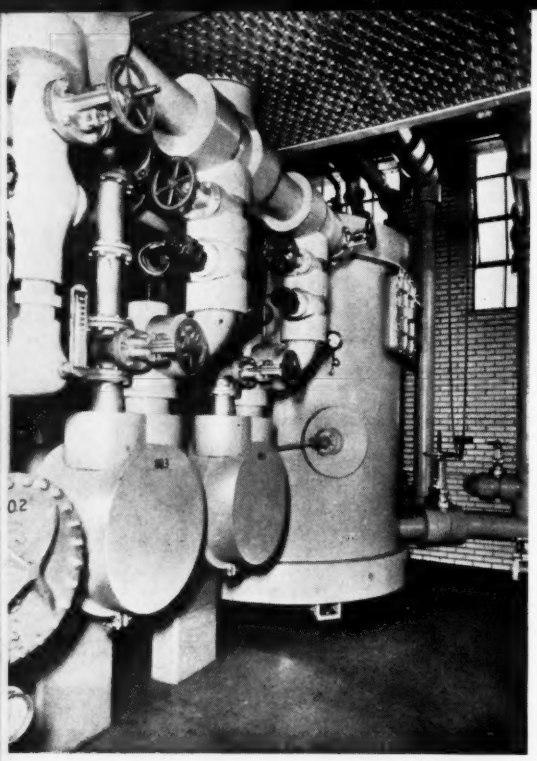
Based on these records, you can depend on Tycol oils for low acidity, low carbon deposition and better demulsibility. You can depend on them for stability, for non-sludging, long-lasting, efficient, economical lubrication!

** Oxidation Number equals unstable parts per 10,000 parts of oil.*

KNOW YOUR OILS

So sure is Tide Water of Tycol superiority that it is making an unprecedented offer to buyers of turbine and Diesel oils. Tide Water will be glad to *re-refine for you,* by its Edeleanu Process, a sample of the turbine and Diesel lubricating oils you are now using. Not only that, Tide Water will welcome the presence of your own technologists, at the time.

Write for the complete Laboratory Report, "Re-refining 12 Brands of Oils." Tide Water Oil Sales Corporation, 17 Battery Place, New York.

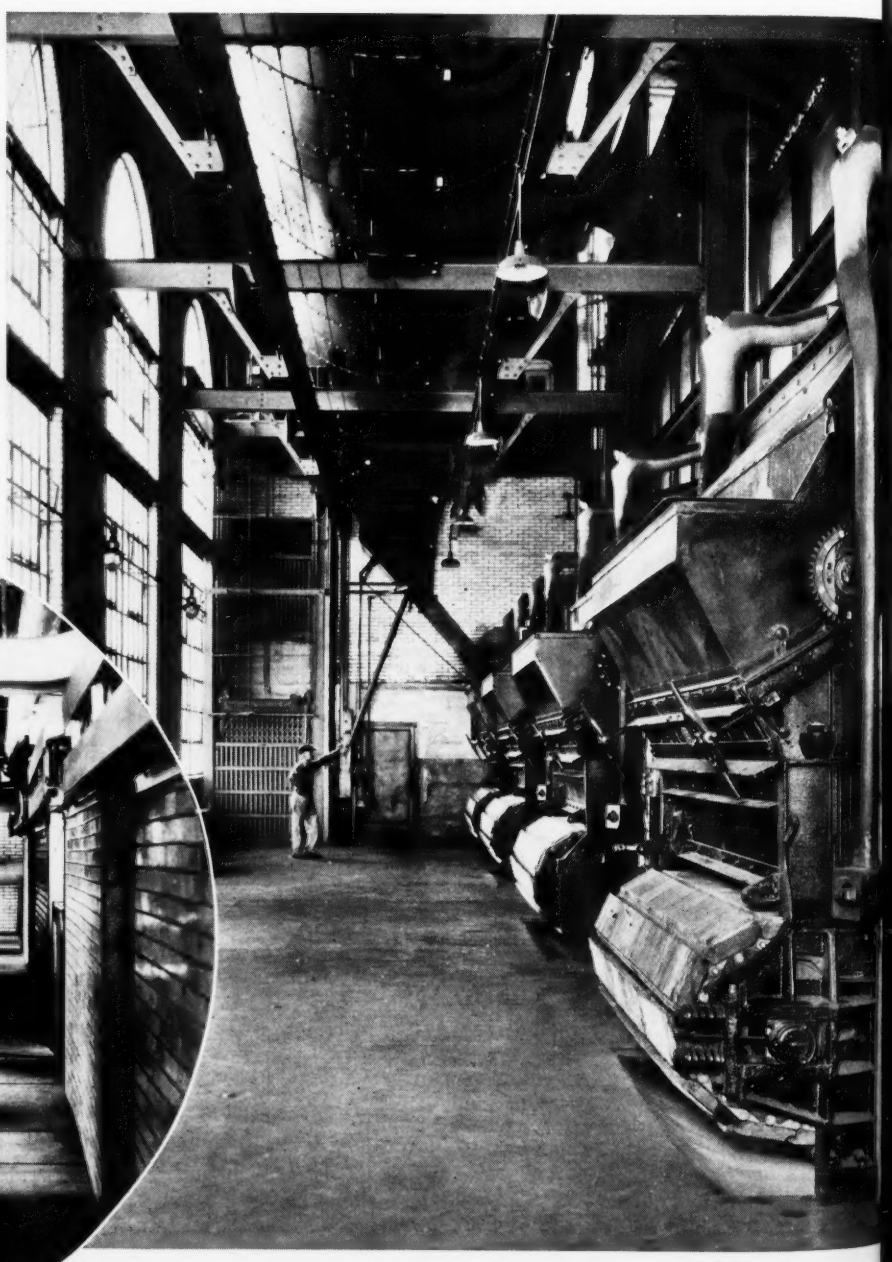


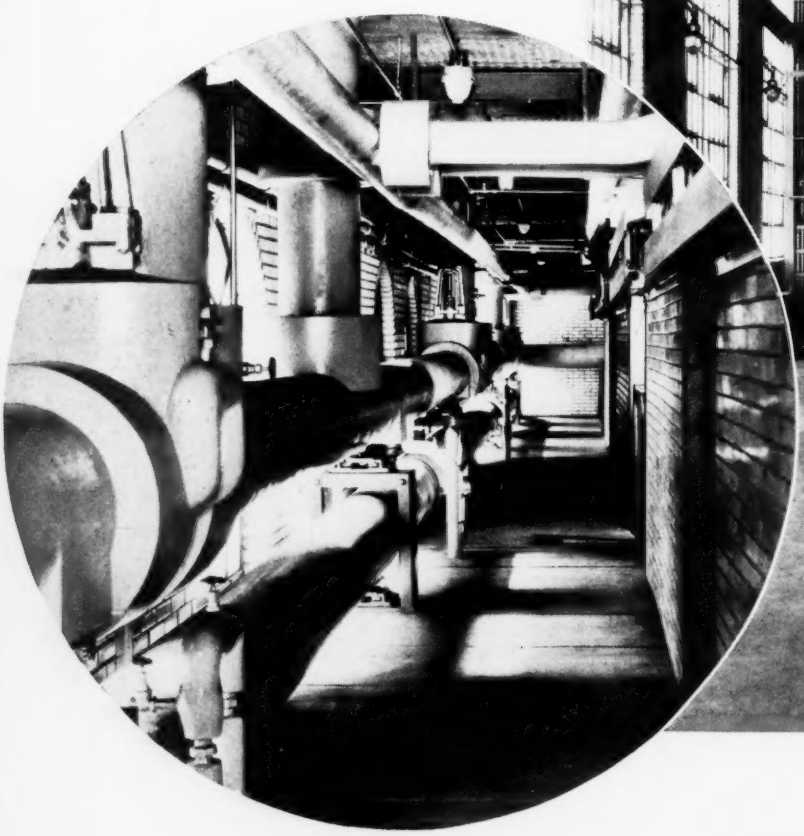
ONE PLANT SERVES

Completely rebuilt and modernized after seventeen years of service, the plant of the Washington University Medical School now delivers dependable power services to eleven medical institutions covering ten city blocks and including a building volume of 20,000,000 cu.ft.

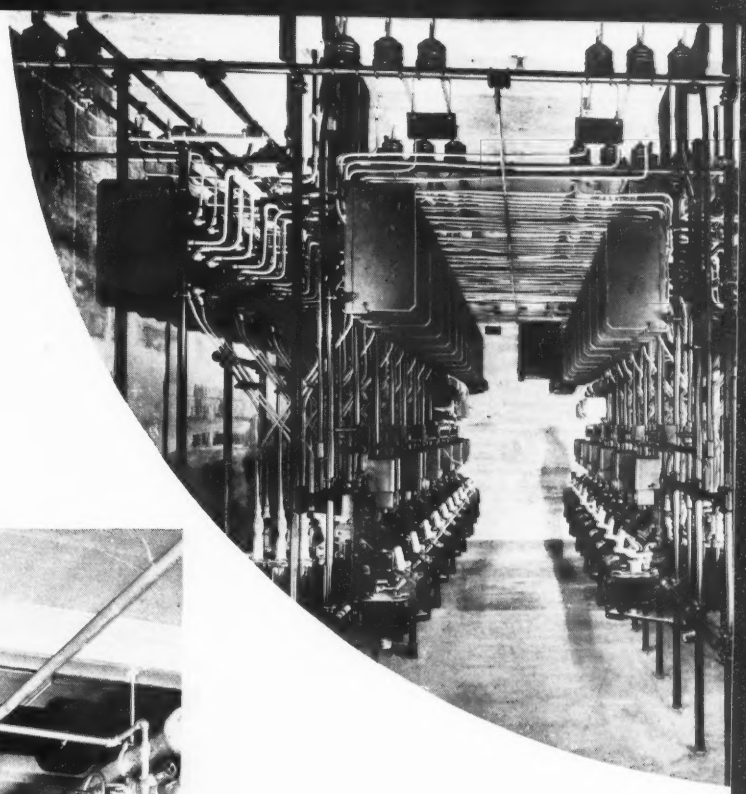
COAL TO STEAM

FIRST COMES COAL, FED FROM AN OVERHEAD BUNKER THROUGH A WEIGH LARRY TO CHAIN-GRATE STOKERS FIRING FOUR 5,531-SQ.FT. WATER-TUBE BOILERS. HOT FEED-WATER COMES FROM A DIRECT-CONTACT DEAERATING HEATER (ABOVE). STEAM AT 225 LB. PRESSURE IS DELIVERED TO THE SECTIONALIZED RING HEADER (BELOW), PASSING THROUGH THE PIPE GALLERY BEHIND THE BOILERS

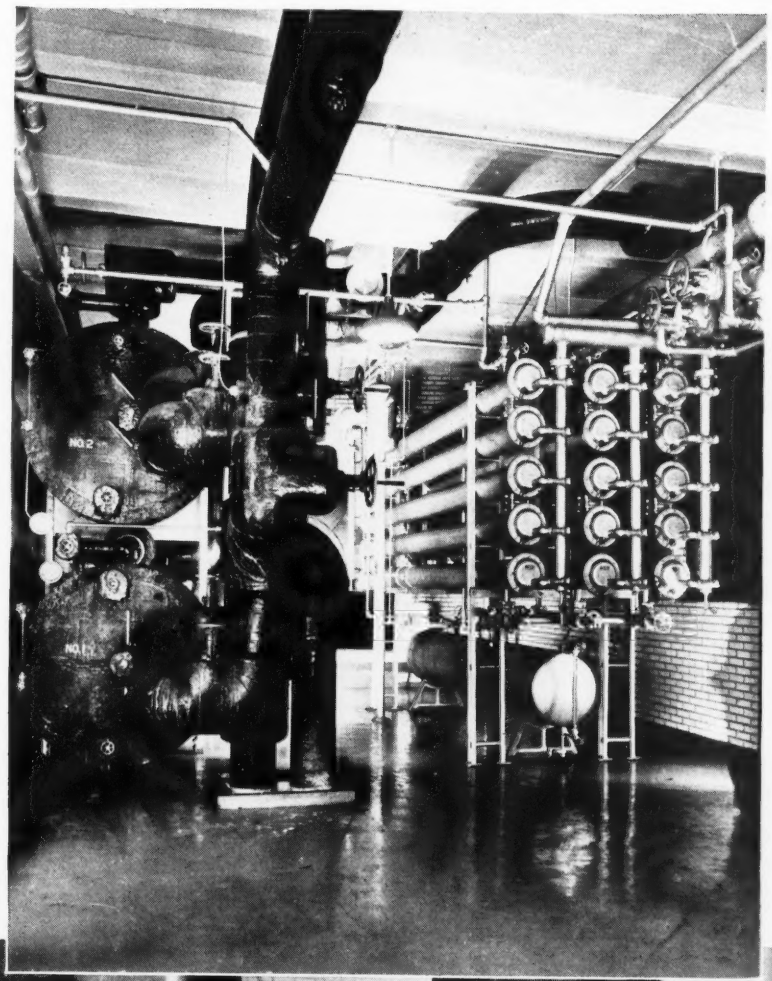




11 INSTITUTIONS IN ST. LOUIS

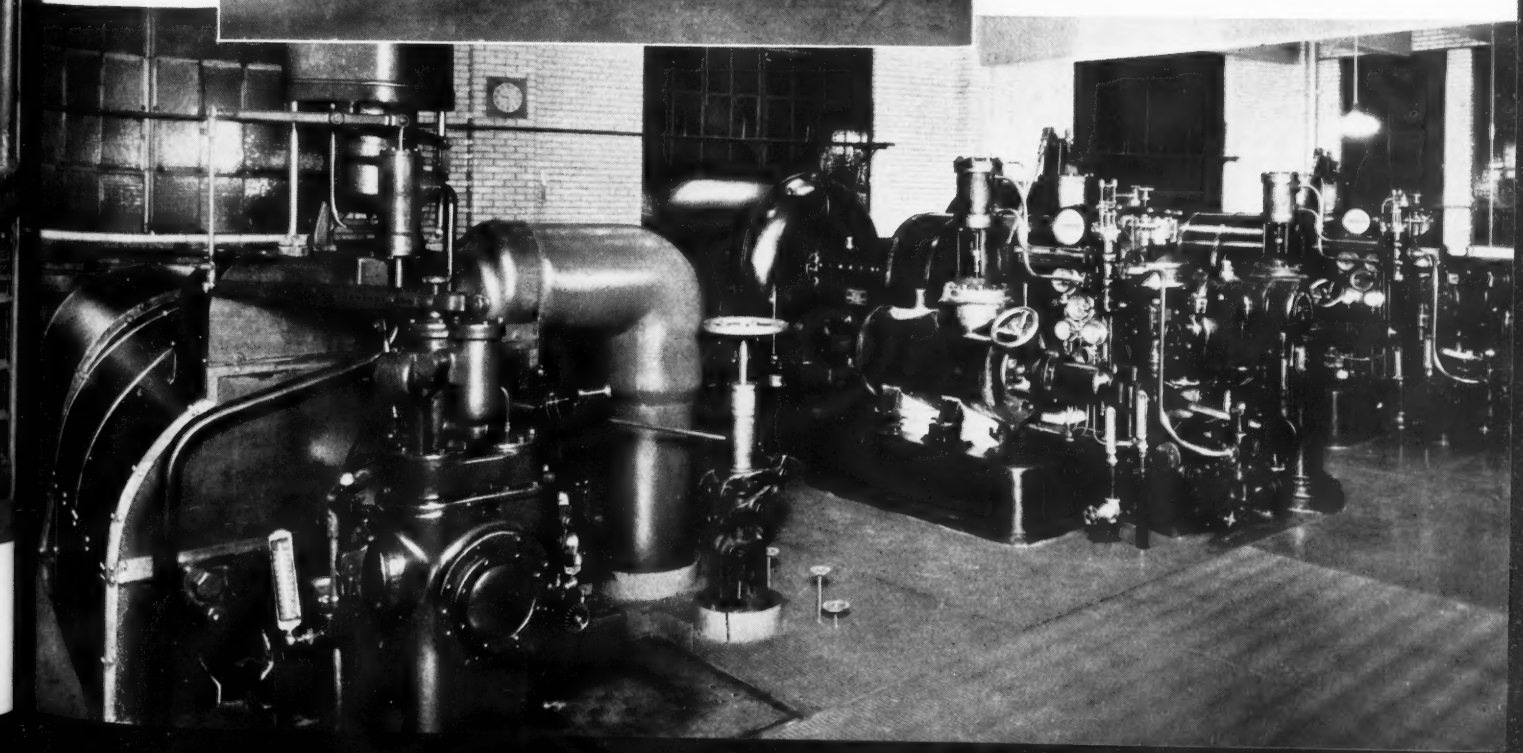


Photographs courtesy Baumes-McDevitt Company

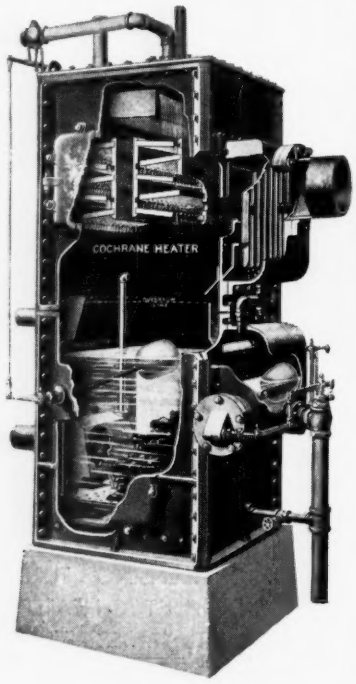


ELECTRICITY HEAT—REFRIGERATION

ONE 1,563-KVA. AND TWO 600-KVA. NON-CONDENSING TURBINES (BELOW) EXHAUST TO HEATERS PRODUCING HOT WATER FOR BUILDING HEATING, DOMESTIC SERVICE AND BOILER FEED. ELECTRICITY, GENERATED AT 2,300 VOLTS, IS REMOTE-CONTROLLED (BUS STRUCTURE AND OIL SWITCHES SHOWN ABOVE). REFRIGERATION IS PRODUCED BY TWO 50-TON AND ONE 40-TON SYNCHRONOUS-MOTOR DRIVEN COMPRESSORS. AT LEFT ARE THE MULTI-PASS SHELL-AND-TUBE TYPE BRINE COOLERS AND AMMONIA CONDENSERS



COCHRANE OPEN HEATER

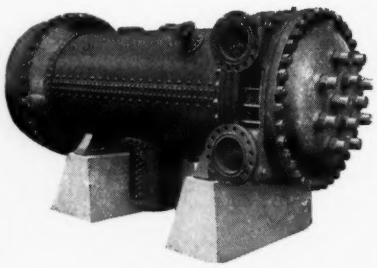


Saves Heat Units

EXHAUST steam, instead of being wasted, is utilized to heat the boiler feed water, of which it becomes part, thereby saving water as well as heat. The water is heated to 210 deg. F. at atmospheric pressure, and one per cent of fuel is saved for each 11 deg. F. rise in temperature. The Cochrane Heater serves as a hot well or return tank and as an automatic cold water regulator. Extra water storage capacity can be provided as required. The horizontal, cylindrical form is recommended for large capacities or where head room is limited. Built in free exhaust and back pressure types. Over 16,000,000 H.P. in service.

Ask for Bulletin L-688.

COCHRANE CLOSED HEATER



Is Designed For Modern Steam Conditions

THE regenerative heating of boiler feed water by means of bled steam has required the development of a line of heaters characterized by a high rate of heat transfer, accessibility of heating surfaces and special provisions to eliminate expansion and contraction strains. Straight tubes are used, with one or more passes and fixed, floating or multiple floating heads, depending upon temperature rise and other conditions. The tubes are accessible upon removing the water box and floating head covers. Through bolts secure the outside flanges and covers. Cast iron, cast steel and steel plate shells are supplied.

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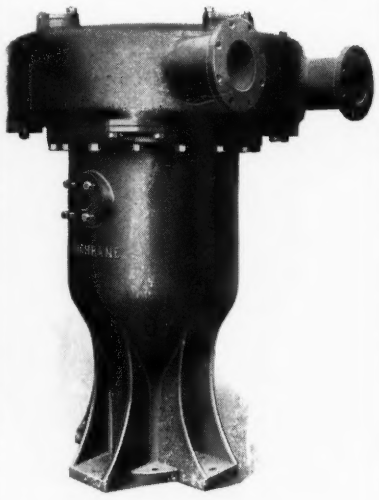
COCHRANE JET HEATER



Has Great Capacity In Small Space

THE Cochrane Jet Heater is peculiarly suited to large capacities, as over 200,000 gal. per hr. It occupies small space, is low in weight, and in large capacities, is low in cost. It heats the water close to steam temperature and, due to a patented nozzle arrangement, is efficient at fractional loads as well as at full load. It can be combined with softeners, meters or storage tanks and can be supplied with a barometric column or with the usual open heater accessories.

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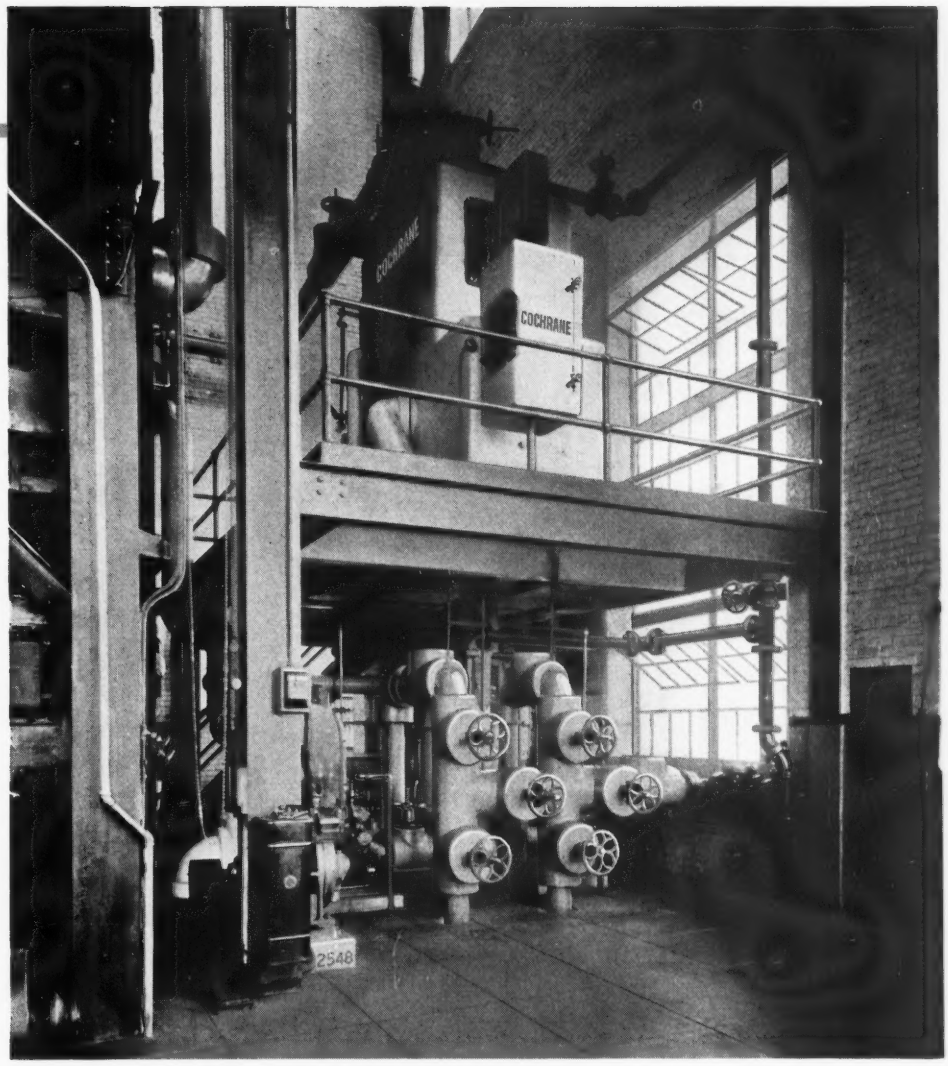
COCHRANE CORPORATION

17th & Clearfield Sts., Philadelphia, Pa.

H-26

Much More than a Feed Water Heater



A TIDY INSTALLATION

THE COCHRANE METERING and DEAERATING FEED WATER HEATER in the Wilson Municipal Power and Light Plant, Wilson, N. C., which is here shown, has the capacity to heat 130,000 lb. per hr. of feed water exactly to the temperature of the exhaust steam.

At the same time, dissolved gases are expelled from the water, so that it cannot cause oxygen corrosion of economizers, boilers and piping.

Further, the water is accurately metered, affording an accurate check upon the quality of fuel and the method of burning it.

Cochrane Deaerating Heaters are operated under all vacua or back pressures, or under variable pressure, and can be combined with V-notch meters, storage or surge tanks or hot process softeners.

COCHRANE CORPORATION

17th and Clearfield Streets, Philadelphia, Pa.

H-44

POWER'S DATA SHEETS

NUMBER 1—PART 2

POWER UNIT CONVERSIONS

DENSITY

Tons are 2,000 lb.; Gallons are U.S. (231 cu.in.)

	Oz. per Cu. In.	Oz. per Cu. Ft.	Lb. per Cu. In.	Lb. per Cu. Ft.	Lb. per Cu. Yd.	Tons per Cu. Ft.	Tons per Cu. Yd.	Lb. per Gal.
Ounces per cubic inch		1728	.06250	108	2916	.054	1.458	14.438
Ounces per cubic foot	.57870 L 3		.36169 L 4	.0625	1.6875	.3125 L 4	.84375 L 3	.83549 L 2
Pounds per cubic inch	16	27648		1728	46656	.864	23.328	231
Pounds per cubic foot	.92592 L 2	16	.57870 L 3		27	.0005	.0135	.13368
Pounds per cubic yard	.34293 L 3	.59259	.21433 L 4	.37037 L 1		.18519 L 4	.0005	.49512 L 2
Tons per cubic foot	18.518	32000	1.1574	2000	54000		27	267.36
Tons per cubic yard	.68585	1185.2	.42866 L 1	74.074	2000	.37037 L 1		9.9024
Pounds per gallon	.69264 L 1	119.69	.43290 L 2	7.4805	201.97	.37403 L 2	.10099	

PRESSURE

	In. Wtr. (60 Deg.)	Ft. Wtr. (60 Deg.)	In. Hg. (62 Deg.)	Ft. Hg. (62 Deg.)	Oz. per Sq. In.	Oz. per Sq. Ft.	Lb. per Sq. In.	Lb. per Sq. Ft.
Inches water (60 deg.)		.83333 L 1	.73681 L 1	.61401 L 2	.57740	83.146	.36088 L 1	5.1967
Feet water (60 deg.)	12		.88417	.73681 L 1	6.9288	997.75	.43306	62.360
In. mercury (62 deg.)	13.572	1.1310		.83333 L 1	7.8370	1128.5	.48981	70.532
Feet mercury (62 deg.)	162.86	13.572	12		94.044	13542	5.8777	846.38
Ounces per square in.	1.7319	.14433	.12760	.10633 L 1		144	.625 L 1	90
Ounces per square ft.	.12027 L 1	.10023 L 2	.88613 L 3	.73844 L 4	.69444 L 2		.43403 L 3	.625 L 1
Pounds per square in.	27.710	2.3090	2.0416	.17013	16	2304		144
Pounds per square ft.	.19243	.16036 L 1	.14178 L 1	.11815 L 2	.11111	16	.69444 L 2	

WORK — ENERGY — HEAT

(Bases: 1 Kilowatt-hour = 3411.5 B.t.u. and 1 B.t.u. = 778.57 ft.lb.)

	B.t.u.	In.-Lb.	Ft.-Lb.	Watt Hr.	Kw.-Hr.	Kw.-Days	Kw.-Yrs.	Hp.-Hr.	Hp.-Days	Hp.-Yrs.
B.t.u.		9342.8	778.57	.29313	.29313 L 3	.12214 L 4	.33461 L 7	.39322 L 3	.16384 L 4	.44886 L 7
Inch-pounds	.10703 L 3		.83333 L 1	.31374 L 4	.31374 L 7	.13073 L 8	.35812 L 11	.42088 L 7	.17536 L 8	.48043 L 11
Foot-pounds	.12844 L 2	12		.37649 L 3	.37649 L 6	.15687 L 7	.42975 L 10	.50505 L 6	.21044 L 7	.57651 L 10
Watt-hours	3.4115	31873	2656.1		.001	.41667 L 4	.11415 L 6	.13415 L 2	.55896 L 4	.15313 L 6
Kilowatt-hours	3411.5	31873 R 3	26561 R 2	1000		.41667 L 1	.11415 L 3	1.3415	.55896 L 1	.15313 L 3
Kilowatt-days	81876	76495 R 4	63746 R 3	24000	24		.27397 L 2	32.196	1.3415	.36753 L 2
Kilowatt-years	29885 R 3	27920 R 7	23267 R 6	87600 R 2	8760	365		11752	489.65	1.3415
Horsepower-hours	2543.1	23760 R 3	198 R 4	745.45	.74545	.31061 L 1	.85093 L 4		.41667 L 1	.11415 L 3
Horsepower-days	61034	57024 R 4	47520 R 3	17891	.17891	.74545	.20423 L 2	24		.27397 L 2
Horsepower-years	22278 R 3	20814 R 7	17345 R 6	65301 R 2	6530.1	272.09	.74545	8760	365	

POWER

(Bases: 1 kilowatt-hour = 3411.5 B.t.u. and 1 B.t.u. = 778.57 ft.lb.)

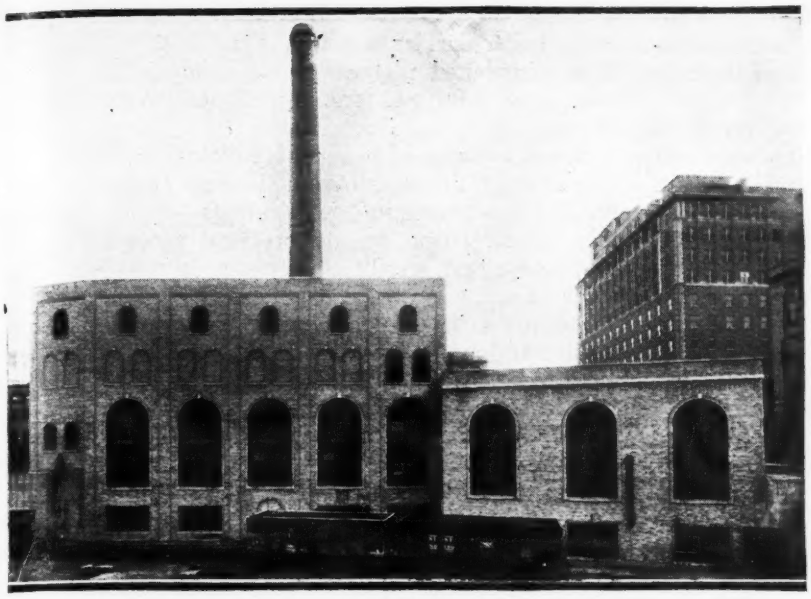
	Watts	Kw.	Hp.	Ft. Lb. per Sec.	Ft. Lb. per Min.	Ft. Lb. per Hr.	B.t.u. per Sec.	B.t.u. per Min.	B.t.u. per Hr.	B.t.u. per Day	B.t.u. per Yr.
Watts		.001	.13415 R 2	.73781	44.268	2656.1	.94765 L 3	.56859 L 1	3.4115	81.876	29885
Kilowatts	1000.		1.3415	737.81	44268	26561 R 2	.94765	56.859	3411.5	81876	29885 R 3
Horsepower	745.45	.74545		550	33000	198 R 4	.70642	42.384	2543.1	61034	22278 R 3
Foot pounds per second	1.3554	.13554 L 2	.18181 L 2		60	3600	.12844 L 2	.77064 L 1	4.6238	110.97	40505
Foot pounds per minute	.22589 L 1	.22589 L 4	.30302 L 4	.16667 L 1		60	.21407 L 4	.12844 L 2	.77064 L 1	1.8495	675.08
Foot pounds per hour	.37649 L 3	.37649 L 6	.50503 L 6	.27778 L 3	.16667 L 1		.35681 L 6	.21407 L 4	.12844 L 2	.30826 L 1	11.251
B.t.u. per sec.	1055.3	1.0553	1.4156	778.57	46714	28029 R 2		60	3600	86400	31536 R 3
B.t.u. per min.	17.588	.17588 L 1	.23593 L 1	12.976	778.57	46714	.16667 L 1		60	1440	52560 R 1
B.t.u. per hour	.29314	.29313 L 3	.39322 L 3	.21627	12.976	778.57	.27778 L 3	.16667 L 1		24	8760
B.t.u. per day	.12214 L 1	.12214 L 4	.16384 L 4	.90112 L 2	.54067	32.441	.11574 L 4	.69444 L 3	.41667 L 1		365
B.t.u. per year	.33461 L 4	.33461 L 7	.44886 L 7	.24688 L 4	.14813 L 2	.88873 L 1	.31710 L 7	.19026 L 5	.11415 L 3	.27397 L 2	

VOLUME RATES

(Month used is exactly one-twelfth year)

	Cu.Ft. per Sec.	Cu.Ft. per Min.	Cu.Ft. per Hr.	Cu.Ft. per Day	Cu.Ft. per Month	Cu.Ft. per Year	Gal. per Sec.	Gal. per Min.	Gal. per Hour	Gal. per Day	Gal. per Month	Gal. per Year
Cubic feet per second		60	3600	86400	26280 R 2	31536 R 3	7.4805	448.83	26930	64632 R 1	19659 R 3	23591 R 4
Cubic foot per minute	.16667 L 1		60	1440	43800	52560 R 1	.12468	7.4805	448.83	10772	32765 R 1	39318 R 2
Cubic feet per hour	.27778 L 3	.16667 L 1		24	730	8760	.20779 L 2	.12468	7.4805	179.53	5460.8	65529
Cubic feet per day	.11574 L 4	.69444 L 3	.41667 L 1		30.417	365	.86579 L 4	.51948 L 2	.31169	7.4805	227.53	2730.4
Cubic feet per month	.38052 L 6	.22831 L 4	.13699 L 2	.32877 L 1		12	.28465 L 5	.17079 L 3	.10248 L 1	.24594	7.4805	89.766
Cubic feet per year	.31710 L 7	.19026 L 5	.11415 L 3	.27397 L 2	.83333 L 1		.23721 L 6	.14232 L 4	.85390 L 3	.20494 L 1	.62338	7.4805
Gallons per second	.13368	8.0208	481.25	11550	35131 R 1	42158 R 2		60	3600	86400	26280 R 2	31536 R 3
Gallons per minute	.22280 L 2	.13368	8.0208	192.50	5855.2	70262	.16667 L 1		60	1440	43800	52560 R 1
Gallons per hour	.37133 L 4	.22280 L 2	.13368	3.2083	97.586	1170.4	.27778 L 3	.16667 L 1		24	730	8760
Gallons per day	.15472 L 5	.92833 L 4	.55700 L 2	.13368	4.0661	48.793	.15574 L 4	.69444 L 3	.41667 L 1		30.417	365
Gallons per month	.50868 L 7	.30520 L 5	.18313 L 3	.43950 L 2	.13368	1.6042	.38052 L 6	.22831 L 4	.13699 L 2	.32877 L 1		12
Gallons per year	.42390 L 8	.25434 L 6	.15260 L 4	.36624 L 3	.11139 L 1	.13368	.31710 L 7	.19026 L 5	.11415 L 3	.27397 L 2	.83333 L 1	

THESE tables are a continuation of those printed in *Power* for July, and are specially computed for the needs of power engineers. Any quantity, expressed in the units listed at left in the tables, will, if multiplied by any factor to its right in the same line, give the equivalent quantity in the unit heading the column. Where "L" or "R", with a number, is printed immediately below the factor, move the decimal point *left* or *right* (respectively) the indicated number of places.



Upper stories were added to the original power plant building to accommodate the modern equipment now installed

To supply dependable power services to a great medical center, including eleven institutions that aggregate 20,000,000 cu.ft. of building space, the power station of the Washington University School of Medicine has been rebuilt and completely modernized. All services are metered and billed

POWER FOR MEDICINE

MODERNIZED PLANT SERVES 11 INSTITUTIONS IN ST. LOUIS

AFTER 18 years of operation, the power station of the Washington University School of Medicine at Saint Louis has been rebuilt and completely modernized. This station furnishes a varied group of power services to the hospitals and institutions which, with the School of Medicine as a nucleus, form one of the largest medical groups in the United States.

This group includes: (1) The medical school and its various clinics, (2) Nurses training school and residence (accommodations for 375 nurses), (3) Dental-school buildings, (4) Building for occupational therapy, (5) Barnes hospital (300 beds), (6) St. Louis Children's Hospital (143 beds), (7) St. Louis Maternity Hospital (104 beds), (8) Shriners' Hospital for Crippled Children. Recently several additions have been made to the center. These are: (9) McMillan Hospital and the Oscar Johnson Institute for treatment of the eye, ear, nose and throat, (10) Mallinckrodt Institute of Radiology, (11) Barnes Hospital Surgical building.

In all, the Medical Center occupies ten city blocks and includes a total building volume of 20,000,000 cu.ft.

The concentration of these institutions, with their various research, clinical and hospitalizational activities, into one group materially expands their individual facilities and offers opportunity, in addition, for administrative economy. With the exception of the University units they are all under separate financial and administrative control, with extensive exchange of medical and some administrative services. Distribution from a common source of the power services is perhaps the most important of these administrative economies.

This center has grown rapidly, and power service requirements have likewise expanded. This has created a rapidly growing demand which outstripped the capacity to serve of the then-existing power station.

Accordingly, studies were made which led to the building of the present modern plant having adequate capacity to supply economically present and future needs. The firm of Baumes-McDevitt Co., consulting engineers, St. Louis, analyzed the requirements and designed and supervised the reconstruction of the present building and installation of all the equipment.

The governing factor in designing this plant has been the vital necessity for continuity of the services supplied. Room temperatures cannot be dropped in hospitals in mid-winter while hasty repairs are made to heating equipment. A temporary loss of refrigeration would mean ruin to carefully protected cultures representing months of continuous laboratory investigation by research scientists. The frequency of major operations in one or all of the numerous operating arenas, and the urgency of radiological examination, makes it imperative that a continuous supply of steam for heating and sterilizing, hot and cold water, refrigeration and electrical energy for power and light services be immediately available at all times.

In view of the exacting demands, the major equipment, as well as practically all of the auxiliaries, are in duplicate. Certain essential auxiliaries are provided with steam drive.

Space for the new plant was limited to the site of the existing plant by the University's contemplated building program. Luckily, the original structure had been planned for a basement plant located under a 3-story building. The original foundations were installed on this basis, but the three stories were never added. These foundations made it possible to increase the height of

the building to accommodate the new equipment. Additional foundations were provided for the highly concentrated loads occasioned by the installation of the new boilers and coal bunker.

The primary services supplied are electricity (both alternating and direct current) for light and power, and steam at three pressures. As rebuilt, the plant's main equipment includes the following:

Four 5,531 sq.ft., bent-tube, multi-drum boilers, are fired by forced-draft chain-grate stokers.

Air for combustion purposes is supplied by two motor-driven forced-draft fans and one turbine-driven fan. (These fans discharge to a common duct, which in turn serves the stokers through branch ducts.)

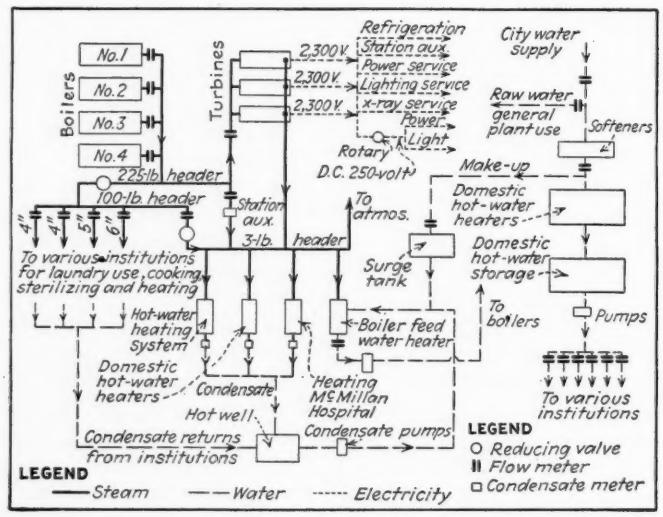
Coal is received by rail and delivered to a track hopper. From this point, it is conveyed by an apron feeder to a gravity discharge elevator and distributed over a 600-ton bunker by a belt conveyor with traveling tripper. The coal is delivered to the individual stoker hoppers by a 4,000-lb. motor-driven traveling weigh larry.

Generating equipment consists of two 600-kva., and one 1,563-kva., 3-phase, 60-cycle, 2,300-volt, non-condensing turbo-generators.

The plant's switch structure carries out the idea of continuous service throughout. In addition to the main bus, a transfer bus has been provided with segregating breakers. Remote-control oil switches allow the placing of any or all feeders on either bus. A separate station lighting system is supplied with an automatic cut-over, so that in case of failure of the station lighting transformer the emergency lighting system is automatically cut over to a storage battery.

Station auxiliaries are supplied from two 300-kva. transformers, 2,300/230 volts, one of which is a spare. Watt-hour meters are provided for measuring the output of each generator and of each feeder leaving the station bus.

Alternating current is generated at 2,300 volts and is distributed at the same voltage over a new 3-phase, 3-wire, primary system to the different buildings, each of which has an individual substation for transformation and interior distribution. The Radiological Institute is provided with three separate feeders from the plant, one for lighting, one for power and one for radiological equipment. A relatively small portion of the generation is passed through rotary converters and the direct current distributed to a few of the older buildings.



Diagrammatic layout of steam, water and electric distribution system

Steam is generated at 225 lb. and goes to the turbines at that pressure. The distribution of steam may best be understood by study of the plant steam, electric and water distribution chart shown in the diagram. Sufficient steam to generate the electrical requirements goes to the turbines and station auxiliaries, and discharges at 3-lb. into the low-pressure header.

Steam for the 100-lb. header comes direct from the main boiler header through a reducing-valve station. It is distributed to the various buildings through two 4-in., one 5-in. and one 6-in. lines, passing through tunnels.

Steam is supplied to all the buildings at 100-lb. pressure through this distribution system. Individual reducing valve stations in the buildings themselves reduce this 100-lb. steam to the pressure necessary for the heating systems, sterilizing, cooking, laundry service and other uses.

Steam for the 3-lb. header is derived partly from the turbine and station auxiliaries exhaust, the balance coming through a second reducing valve station from the 100-lb. header. This steam is used for the hot-water heating system, as a number of the older buildings are heated with hot water; heaters and pumps serving this system are located in the plant.

In addition, steam is supplied at 3-lb. pressure for vapor heating direct to McMillan Hospital, which is adjacent to the plant. Steam from this low-pressure header is used for feed-water heating within the plant itself. The further use of low-pressure steam is occasioned by the domestic hot-water system located in the plant. This supplies softened hot water to all the institutions and laundries.

All condensate from the hot-water heating system, the domestic hot-water heaters and returns from McMillan Hospital is metered and returned to a hot well. All condensate from the 100-lb. distribution system is also returned to the hot well in the plant. Approximately 85 per cent of the steam generated is recovered as condensate, thereby reducing the city water make-up. Condensate is pumped from the hot well to an overhead surge or make-up tank, from which it flows by gravity to a deaërating heater and, in turn, is pumped to the boilers.

Raw city water is metered into the plant and passes through zeolite softeners. A small portion of this softened water is used for boiler make-up. The major portion goes to the domestic hot-water generators and discharges into an overhead storage tank of 20,000 gal. capacity. The flow of water is regulated to utilize low-pressure steam from the turbines advantageously. Storage facilities permit the use of exhaust steam the major portion of the time in order to avoid the use of live steam for this purpose at certain times of the day.

Domestic hot water is supplied to the various institutions from the storage tank by means of pumps, the system being arranged for recirculation in order properly to maintain the temperature of the water.

One of the interesting classes of service rendered by this plant is refrigeration. A total of 25,000 cu.ft. of

cold-storage space is located throughout the various institutions for kitchen service, laboratories, specimens and mortuaries. Cold drinking water requirements add a further demand for this service. Motor-driven ammonia compressors, brine coolers, ammonia condensers, cooling tower and brine pumps are all in the central station.

Complete and continuous metering is maintained, not only of all the services supplied but on plant production as well. Meter locations are shown on the distribution chart. This permits accurate analysis of plant production and distribution.

An analysis of the requirements indicated an average demand of approximately 125,000 lb. of steam per hour during extremely cold weather. Three of the four boilers installed, operating at about 225 per cent continuous rating, will supply this, with the fourth as a standby.

Peak demands during the summer or non-heating season will average about half of the winter requirements. Night loads vary to a large extent with the weather. During extremely cold weather, steam load will not vary more than 20 per cent, since all buildings are maintained at an average temperature throughout the 24 hours.

Weather conditions have marked influence on electric demand as well. Principal power uses are for station auxiliaries, air conditioning, refrigeration, and elevator and laundry service. General illumination of corridors in certain portions of all buildings is necessary during the entire 24 hours.

On a normally bright day the total demand, including both power and light, averages about 1,000 kw. During the hours from 10:00 p.m. to 6:00 a.m. this load drops to about 600 kw. Very dark days occasion still greater demand, due to the necessity for general lighting of the entire group. The electrical load is very uniform and practically without peak.

Operation of this station is under the supervision of H. J. Stiebel, chief engineer and superintendent of maintenance of Washington University.

MECHANICAL AND ELECTRICAL EQUIPMENT
EUCLID AVENUE POWER STATION
WASHINGTON UNIVERSITY SCHOOL OF MEDICINE

Building Volume: Total cubical contents.....640,000 cu.ft.
Boilers: Four bent-tube, 4-drum, 5,531-sq.ft., 250 lb. pressure, no superheat.....Babcock & Wilcox Co.
Boiler Settings: Boilers set singly, center line of mud drum 14 ft. 0 in. above floor. Furnace volume 1,525 cu.ft. Furnace walls solid refractory, with expansion joints. Exterior, enamel brick veneer.
Stokers: Four Coxe forced-draft chain grate, grate area 143.8 sq. ft. high-pressure side-wall water boxes and waterbacks with connections to boilers.....Combustion Engr. Corp.
Forced Draft Fans: Three Clarage, each 21,000-c.f.m., 4.5-in. water, 1,750 r.p.m. (Two motor-driven, 2,300-volt, Westinghouse) (One turbine-driven, Terry).....Clarage Fan Co.
Chimney: Hollow tile, reinforced concrete construction, 9 ft. 0 in. diameter at top, 200 ft. high.....Wiederholdt Const. Co.
Boiler Feed Pumps: Three 250-g.p.m., 550-ft. head, 1,760-r.p.m. (Two motor-driven, 2,300-volt, Westinghouse) (One turbine-driven, Allis-Chalmers).....Dean Hill Pump Co.
Boiler Feed-Water Heater: Direct-contact deaerating type, 260,000 lb. per hour, from 40 deg. to 215 deg.....Elliott Co.
Condensate Recovery Pumps: Two 250-g.p.m. each, 125-ft. head, 1,750-r.p.m. (Motor-driven, Westinghouse),
Warren Steam Pump Co.
Air Compressor: 195-c.f.m., 100-lb. pressure, 570-r.p.m., (Motor-driven, General Electric).....Gardner-Denver Co.
Equipment Water Recovery Pump: One 40-g.p.m., 200-ft. head, 3,450-r.p.m. (Motor-driven, General Electric)
Goulds Pumps, Inc.
Sump Pumps: Two 100-g.p.m., 35-ft. head, 1,740-r.p.m. (Motor-driven, General Electric).....Goulds Pumps, Inc.
Coal Bunker: Parabolic, steel, tile lined, 600 tons active storage.....Designed by engineers
Coal Handling: 50 tons per hour, apron feeder from track hopper to gravity-discharge elevator conveyor. Belt conveyor (18-in.) distributes over bunker through automatic reversing tripper. System equipped with Timken bearings throughout, motor drives with speed reducers..Dodge Mfg. Corp.
Coal Weigh Larry: Motor-operated, traveling, 2 ton,
Dodge Mfg. Corp.
Stoker Ash Hoppers: Steel plate, refractory lined, gravity discharge with Beaumont pivoted shear gates,
Designed by engineers
Ash Handling: Pneumatic system to storage, rotary dustless feeder to cars.....United Conveyor Corp.
Ash Storage: Steel, tile-lined, 60 tons storage,
Designed by engineers
Boiler Feed-Water Regulators:
(Copes) Northern Equipment Co. and Bailey Meter Co.
Soot Blowers:.....The Bayer Co.
Combustion Control: Automatic draft, furnace pressure and stoker control.....Defender Automatic Regulator Co.
Valves:
High-Pressure Steam.....Lunkenheimer Co.
Non-Return Steam.....Edwards Valve & Mfg. Co.
Medium- and Low-Pressure...Crane Co. and The Fairbanks Co.
Blow-off.....Yarnall-Waring Co.
Reducing.....Mason Regulator Co.
Atmospheric Relief....Cochrane Corp. and Fisher Governor Co.
Steam Traps.....Armstrong Machine Works

Turbine Generators:
Two 600-kva.....Allis-Chalmers Mfg. Co.
One 1,563-kva.....General Electric Co.
Turbines: 3,600-r.p.m., 225-gage throttle pressure, no superheat, non-condensing, 5-lb. back pressure.
Generators: 3-phase, 60-cycle, 2,300 volts.
Generator Air Filters:.....American Air Filter Co.
Exciters: Two motor-driven, one turbine-driven,
Allis-Chalmers Mfg. Co.
Rotary Converters: Two 200-kw. each, 180-volt a.c., 250/125-volt d.c.....Allis-Chalmers Mfg. Co.
A.C. Switchboard and Switching Equipment:..General Electric Co.
D.C. Switchboard:.....Frank Adam Electric Co.
Station Power and Lighting Distribution Cabinets:
Wm. Wurdack Electric Mfg. Co.
Station Transformers..Moloney Electric Co. and General Elec. Co.
Domestic Hot-Water Equipment:
Three 80,000-gal. zeolite softeners.....The Permutit Co.
Two hot-water generators, 10,000 gal. per hr. each, from 50 deg. to 180 deg. steam at atm. pressure...Ross Heater & Mfg. Co.
Two hot-water generators, 3,600 gal. per hour each, 50 deg. to 180 deg., steam atm. pressure.....Wainwright make
Two circulating water pumps, 300 g.p.m. each, 150-ft. head, 1,750 r.p.m. (motor-driven, Allis-Chalmers),
Union Steam Pump Co., Inc.
Temperature Regulators.....Powers Regulator Co.

Refrigeration:
Two 10x10-in. ammonia compressors, 225-r.p.m., 50-ton capacity, motor driven.....Frick Co.
One 10x10-in. ammonia compressor, 164-r.p.m., 40-ton capacity, motor driven.....York Ice Machinery Corp.
Two 100-hp. synchronous motors, 225-r.p.m., 2,200-volt, 3-phase, 60-cycle.....Electric Mchy. Mfg. Co.
One 60-hp. synchronous motor, 164-r.p.m., 220-volt, 3-phase, 60-cycle.....General Electric Co.
Two 34-in.x18-ft. horizontal multi-pass shell and tube-type brine coolers, each 820 sq.ft. exchange surface.....Frick Co.
Three stands, horizontal multi-pass shell and tube type ammonia condensers. Receiver, accummulators and valves..Frick Co.
Two brine circulating pumps, 300-g.p.m., 160-ft. head, 1,750-r.p.m. (Motor-driven, Allis-Chalmers),
Worthington Pump & Mchy. Corp.
Cooling Tower: Combined natural and induced draft, 600-g.p.m. Clarage fan and Marley nozzles.....Designed by engineers
Cooling Tower: Combined natural and induced draft, 600-g.p.m. 1,750-r.p.m. (Motor-driven, Allis-Chalmers),
Union Steam Pump Co., Inc.
Cold Drinking Water Pump: 50-g.p.m., 105-ft. head, 3,510-r.p.m. (Motor-driven, General Electric),
Worthington Pump & Mchy. Corp.

Meters and Instruments:
Boiler meters and steam-flow meters.....Bailey Meter Co.
Draft gages, multi-pointers.....Bailey Meter Co.
Recording thermometers.....Foxboro Co.
Indicating thermometers.....Taylor Instrument Cos.
Boiler feed-water meter.....Republic Flow Meters Co.
Condensate meters, recording weir type.....Cochrane Corp.
Steam distribution meters.....Bailey Meter Co.
Feed-water heater water level recorder.....Foxboro Co.
Boiler water level indicators.....The Bristol Co.

COAL BUYERS AND SELLERS CHASE RAINBOWS

By A. A. BEMENT
Consulting Engineer, Chicago

ENGINEERS insist on defining the indefinable—for example, coal. At the other extreme are the sellers of coal, many of whom are far from scientific in their attitude toward their own product. That is why the recent history of coal buying, particularly the buying and selling of coal on a guaranteed quality basis, has been largely a comedy of errors.

First, a very brief summary of the effect of coal characteristics. Heat value has generally been considered most important. Some have thought it a complete measure of value, the only proper basis for selecting a fuel supply.

Today most engineers are ready to admit that heat value is only part of the picture, and that in some cases other characteristics may be of greater importance.

Size, or sizing, is often of great importance for stoker use. Where ash content is high the effect on heat value is hardly a measure of the damage it does. In some furnaces fusibility of ash is a critical problem, and may be the determining factor in fuel selection. Still other factors, as every large coal user knows, are decidedly important.

ENTER THE CHEMIST

When the general laboratory testing of coal came into vogue it was natural enough that the matter should drift into the hands of chemists who knew little of utilization problems. They did a lot to establish the idea that the B.t.u. obtainable for a cent is the true measure of the value of a coal.

The scheme of buying coal on a guaranteed quality basis was introduced long before either producer or consumer had any scientific basis for specifying these qualities. This was especially true in the Mid-Western states, where buying on this basis had its more important development and its most spectacular career. Many a comedy was staged, unintentionally, by coal seller or buyer, or both.

"B.T.U.-FREE" COAL

Picture this scene: The sales manager of an important coal company appears before a committee appointed to select fuel supply for a public institution. The committee has been instructed for the inquiry, and asks the sales manager how much moisture his coal contains. He answers that he does not know, but is sure that it has some because the coal is liable to be rained on at any time.

How much ash? Again he is not quite sure, but figures that his coal contains some ash, because ashes are always found after it has been burned; in fact, this is the case with all coal.

How about sulphur? The sales manager cannot name the amount, but is able to say definitely that it contains some or it would not burn.

At this stage of the inquiry he begins to sense an unfavorable impression. He also feels that the questions asked reflect on the quality of his coal. He therefore decides to take the offensive.

"How many B.t.u. does the coal contain?" the committee asked. This sounds pretty bad. Pounding the table with his fist, the sales manager shoots back, "Not a damn one."

In another case the buyer told an operator, call him *A*, that he did not think much of *A*'s coal, because operator *B* had said that it contained no B.t.u. To this operator *A* replied: "He is right. The trouble with *B* is that he cannot get them out of his coal." This settled the matter and *A* got the order.

One of the first testing companies began business with a plan that appealed to the coal user. It acted as agent of the buyer of the coal in selecting the source of supply, testing the coal, determining value and informing the buyer of the amount to be paid for the coal.

Many Chicago office buildings were among those engaging this service. These buildings had been served by various retail companies which delivered by trucks from yards near railroads connected with the mines.

These retail coal companies viewed the new development with alarm. Instead of cooperating they attempted to head the development off by refusing to sell under these guaranteed contracts. That is, they all did, except one operating company with retail affiliations. As a result, this operator got most of the business.

At that time there was no published information giving analytical values of the coals of the region. The testing company was compelled to seek such informa-

tion from a private source that would have been equally available to this group of retail dealers.

The fuel involved in these cases was practically all small prepared coal from southern or central Illinois. The product of these fields is very uniform in quality, regardless of mine or producing company. As these coal users learned this, and also learned that they were in many cases receiving coal from the same mine as before, they abandoned the service of the testing company.

The argument that if the buyer paid a bonus it was because he received better coal lost standing when it came to be realized that such superiority did not exist. On the other hand, the seller did not feel disposed to be told that he was fortunate to have the business and should not omplain if penalized. This situation led to a sharp decline in buying on a guaranteed basis.

Where Guaranteed Buying Is Justified

There are, however, certain situations where buying on a basis of guaranted quality may have merit. Political bodies, for example, may be justified in following this plan to protect themselves against charges of favoritism. It is nevertheless true that the testing scheme may easily be mishandled. Since the sampling and testing is usually done by the purchaser or his representative, the results obtained are sometimes unfair to the seller. True, provision is sometimes made for duplicate sampling by the seller, but this entails expense that the coal company cannot usually afford. To avoid expense and controversy, the seller compromises.

A state government required bidders to guarantee evaporation that would be obtained from the coal offered. Since this involved combustion efficiency and other matters outside the control of the coal company, reliable companies refused to bid.

Later the successful bidder gave away his secret. He had offered an evaporation that he knew to be unobtainable, since he also knew that the state was not prepared to make any tests.

In the case of a very large screening contract the coal company guaranteed coal of as high quality as possible, yet with some margin in its favor. The buyer was to sample and test the coal, payment to be based on buyer's test results.

At the end of the first month the coal company appeared to owe the buyer several thousand dollars in penalties. The coal company then engaged a few sample takers to work with the buyers' two men. These four men made a joint sample which went to the buyers' laboratory, as before. The result was that, at the next settlement date, the buyer appeared to owe the coal company a larger premium than the former penalty demanded. The buyer then asked to discontinue testing and pay the contract price. On that basis the contract was carried out.

If screenings were uniform as to ash content in different sized pieces of the fuel, sampling would be simplified. However, with the segregation that always occurs, anything approaching correct sampling must be in part a matter of judgment of a competent person.

An Indirect Benefit

The most important benefit that has resulted from the attempt to establish a scheme of buying on a guaranteed quality basis is the indirect educational influence. The resulting studies have led to much useful data.

Selling on a guaranteed basis would be more simple if coal were a manufactured product. Actually, the producer's power is limited to the removal of a portion of the dirt or impurity, then grading the coal to size by the screening process.

Laundry Superheater Speeds Work and Cuts Fuel Bill

By H. M. FRIEND
Bronxville, N. Y.

WHILE large steam power plants invariably use superheated steam, many small industrial plants, particularly those where old boilers are still in operation, operate on saturated steam exclusively. That such plants could profit by the installation of superheaters is indicated by the experience of the National Laundry Co., Washington, D. C. There superheaters, recently applied to boilers supplying laundry equipment and a steam engine, increased output, reduced unit labor costs and cut the fuel bill.

This installation is of particular interest because a newly developed type of superheater, applicable to return-tubular boilers, was installed, and because the savings obtained were the combined effect of increased engine efficiency, more effective laundry equipment operation and better boiler efficiency.

The general power and process layout is indicated by the accompanying diagram. The two horizontal-return-tubular boilers have 72-in. shells and tubes 18 ft. long. The engine drives a direct-current generator supplying current to some of the laundry equipment. Alternating current for other equipment is purchased.

It will be noted that steam at boiler pressure is supplied to flat-work ironers and pressers. Water for the washing machines is heated normally by engine exhaust, with additional boiler steam supplied as needed through a thermostatically controlled valve.

Condensate from the water heater, the flat-work ironers and the pressers passes to a hotwell through

traps. From the hotwell the condensate is pumped as feed water to the boilers.

Before the installation of a superheater the capacity of the boilers was inadequate to supply sudden demands from the engine and the hot-water heater. As a result of this overloading the boiler pressure would drop rapidly from the operating pressure of 110 lb. gage to as low as 70 lb. Lowered steam pressure correspondingly lowered the process temperature in the ironers and pressers, slowing them down, decreasing output and increasing labor cost. Data on the actual steam rate of the engine, with and without superheat, are not available. It is clear, however, that the decreased steam consumption of the engine with superheated steam is important in eliminating these heavy pressure drops. This would account, in part, for the ability of the management to speed up the ironers and pressers.

The centrifugal clothes dryers ("extractors") are driven by direct-current motors, current for which is furnished by the engine generator. The higher average steam pressure in ironers and pressers makes it possible for them to receive work with a greater percentage of moisture. This in turn reduces the time of operation of the extractors, and the amount of engine power that's required for their operation.

In addition to the operating improvements which arise directly and indirectly from the greater economy of the engine with superheated steam, there is said to be some direct gain from the application of the superheated steam to the ironers and pressers.

A third factor, normally introduced when superheaters are installed, and presumably present in this case, is the improved boiler efficiency resulting from the absorption of additional heat by the superheaters, evidenced by lower flue temperatures.

Ironers Speeded Up 70 Per Cent

Before the superheaters were installed a three-week test was made on the ironer which does family work. This showed an average production of 17 to 18½ lb. per operator per hour. With superheaters installed it was possible to speed the machine up to a production of from 29 to 31 lb. per operator per hour, an increase of about 70 per cent.

A similar test made on another ironer showed an increase in output of approximately 75 per cent.

The management believes that by further adjustment still higher output rates may be obtained, and that machines doing wholesale and linen supply production may be speeded up more than 100 per cent.

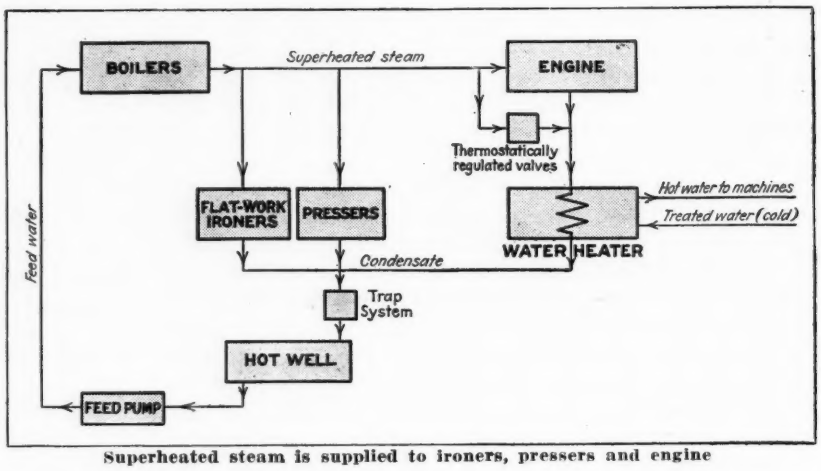
Because of the ability of the ironers and pressers to receive goods with a higher percentage of moisture, the time of operation of the extractors was cut from 25 to 15 min. per lot. An incidental result of this change is a higher polish on the finished articles.

Complete data on the saving in coal are not yet available, as the second superheater was not installed until May 8 of this year. However, for 17 days of the month of May the saving of coal, with approximately the same plant output, was 24 tons—$144 at $6 a ton.

The most striking effects of this installation were the increase in plant capacity and the reduced cost of the work put through. The net result, according to H. S. Taylor, secretary of the company, is that the installation will pay for itself in about six months.

Superheater Under Boiler Shell

The new type of superheater consists of tubular elements of steel extending around and close to the lower half of the horizontal-return-tubular boiler shell in semi-circular form. There the superheating surface is exposed directly to the furnace heat after it passes the bridge wall. The tubes are connected by metal-to-metal ground joints to special cast-steel headers suspended one on each side of the boiler shell. Saturated steam enters one header, and the superheated steam leaves the other. The two superheaters were installed on separate week-ends to avoid interruption of service.



Superheated steam is supplied to ironers, pressers and engine

The experience of the National Laundry Co. is another example of the savings now being made in many small plants equipped with horizontal-return-tubular boilers. Modernization of such units through changes in setting heights, installation of superheaters and application of modern firing equipment frequently results in substantial improvements in capacity and economy at a cost considerably below that of new units.

▼ ▼ ▼

More About Magnitogorsk—The power plants at Magnitogorsk are outstanding examples of the intense desire of the Soviet Government to generate electrical power. Outsiders wonder what they will do with all the power to be generated in such stations as Magnitogorsk and Dnieperstroy when the country is at present so slightly industrialized. However, the Russian engineers have complete and unpublished plans showing how this generated power will be utilized by industry.

At Magnitogorsk, electrical current will be supplied above the metallurgical, mining and chemical projects for power to copper mines and smelters in the Ural District (which had not been started at the time I left) and to Cheliabinsk, an industrial town several hundred miles north of Magnitogorsk.

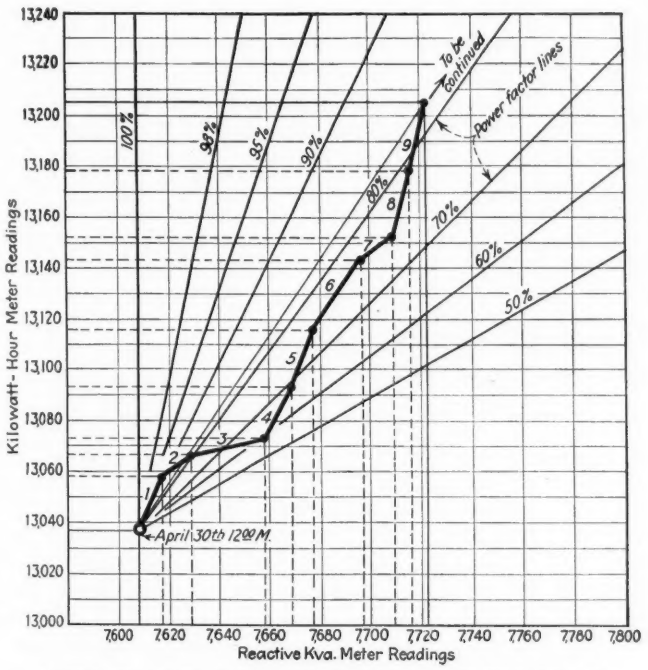
(The above comments from Fred N. Hays arrived too late for inclusion in his article on page 79 of this number. They add to the picture there presented.—Editor).

PRACTICAL AIDS TO OPERATION

Chart Gives Daily Record of Plant Power Factor

PLANTS that purchase power under a contract imposing penalties for low power factor are frequently equipped to improve their plant power factor by the proper use of static condensers or over-exciting synchronous machines. The average power factor during the billing period is determined from readings of the kilowatt-hour meter and the reactive kilovolt-ampere-hour meter. Daily meter readings will give a picture of the average power factor.

The operator of the power-factor improving equipment can, without computations, make his daily entries on a chart, as in the figure, that will show the effectiveness of operation. On a sheet of cross-section paper, a



Zigzag line shows average daily power factor from May 1st to 9th inclusive.

scale is drawn along one side representing the range of the kilowatt-hour during the entire billing period, and at right angles to this another scale is laid off for the reactive kilovolt-ampere-hour meter readings. Each day's reading is then entered as a single point in the space enclosed by both scales, and the successive points connected by straight lines, as in the figure. Through the point of beginning straight lines are drawn denoting different power factors. The angles of these lines against the kilowatt-hour scale are as given in the table, or they may be taken from a table of cosines.

Degrees	Power Factor, per Cent	Degrees	Power Factor, per Cent
11.5	98	25.8	90
16.3	96	28.4	88
20.0	94	30.7	86
23.1	92	32.9	84

The inclination of the line connecting two successive points gives a measure of the power factor during the particular day by comparing it with the line to which it is most nearly parallel. The line connecting the point of beginning with any other point representing a later reading gives the average power factor represented by the period between the two points. With the aid of such a chart it may readily be judged if the schedule of operating the power-factor improving equipment is the right one, if savings could be obtained by changed methods of operation or if additional power-factor-correcting equipment is required.

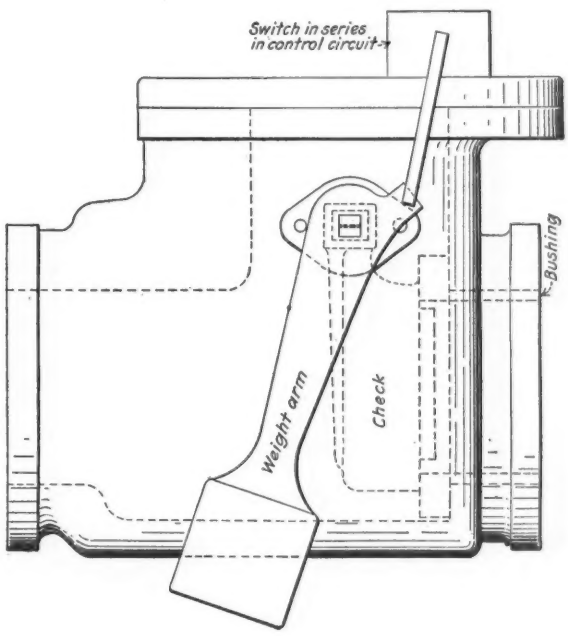
East Pittsburgh, Pa. KURT MAHNKE,
Power Plant Operator,
Westinghouse Electric & Mfg. Co.

Switch Connected to Check Valve Protects Pump

THE question and answers in your June 7 number on protecting pumps against running dry were very interesting. Around the coal mines are many centrifugal pumps which operate for considerable periods of time with no attendance. Some of these are equipped with manufactured devices such as those mentioned in the answers to the question, but many more are home-made and are very effective.

One of the most common is a check valve in the discharge, fitted as shown in the diagram. The weight is so set on the arm that the discharge pressure will hold the valve open when the pump is functioning properly. If the check valve is set properly, a $\frac{1}{4}$-in. hole in the suction pipe will produce sufficient change in pressure to drop the check and trip off the pump motor. Almost any kind of a limit or float switch, manufactured or home-made, can be connected to this arm.

At some mines I have seen a safety switch connected



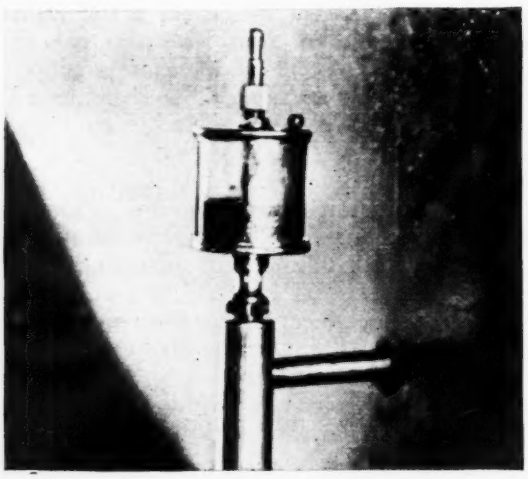
to the foot valve in the suction. If the pump loses its suction, this valve will close and shut down the pump. At one mine, the mine electrician rigged up a cylinder and piston tapped into the discharge and arranged with a coil spring to balance the discharge pressure. This piston was connected by a flexible wire to the no-voltage release on the compensator. If the water pressure failed, the spring would force the piston back, open the no-voltage release and stop the pump.

Johnstown, Pa. F. FRASER MACWILLIAMS.

Lubricator Repaired With Paper and Shellac

WHEN a wild wrench one day ended its flight against a glass lubricator body, repairs were in order. The lubricator served the crankpin bearing of a crude-oil pump on 24-hr. service, seven days a week, and a spare glass was not to be obtained within hundreds of miles. An emergency repair was imperative, but at first there seemed to be no substitute offering the desired visibility.

The problem was solved with shellac and a small oblong of paper, and today the lubricator is as oil-tight as when the repair was made. The shattered glass body

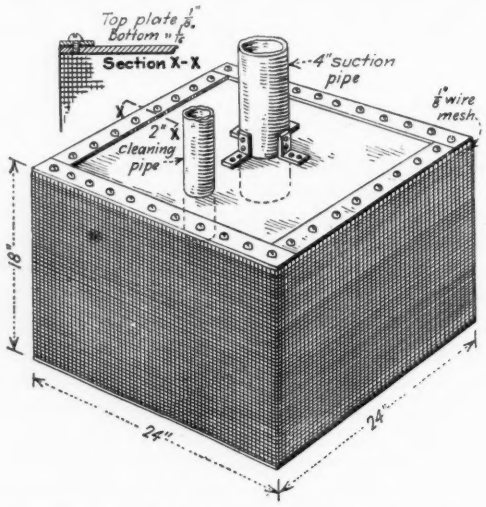


was used without dismantling the lubricator. A paper cover was cut to go over the shattered section, with a $\frac{1}{4}$-in. margin all around. Then, after the glass was cleaned with gasoline and allowed to dry, one side of the paper was shellacked and smoothed down on the broken section, care being taken to work out all air bubbles. A second coating of shellac, brushed on over the outside of the paper, waterproofed and reinforced the job. In operation, the lubricator is turned so the patch is toward the pump, as in the figure, and though covering one-third of the glass, it is inconspicuous.

Longview, Texas. ELTON STERRETT.

A Self-Cleaning Screen for A Pump's Suction Pipe

KEEPING the screen on a pump's suction pipe clean is a problem quite common to operating engineers. We had trouble of this kind on a pump with a 4-in. suction until a strainer of the type shown was developed. The top and bottom of the strainer are made of steel plate with holes in the top plate for the 4-in. suction and the 2-in. cleaning line. All four vertical sides of the strainer are inclosed in $\frac{1}{8}$-in. mesh galvanized screen. The screen is supported directly from the end of the suction pipe by four angles riveted to the screen plate and bolted to the pipe. There is a vacuum gage on



the suction line at the pump, and when it is found that the reading is higher than normal the screen is cleaned. The cleaning pipe is connected to a water supply line through a valve. To clean the screen the valve is opened and water flows back into the screen box. Because of the bottom plate the water is deflected and caused to flow out in all directions and carries away any leaves, grass or other material that may have collected on the screen. Allowing the water to flow for one or two minutes is usually sufficient to clean the screen.

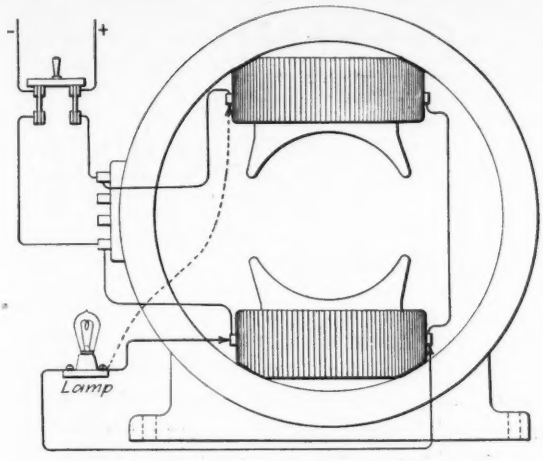
Cleveland, O. C. A. STEVENS.

One Field Coil Short Circuited Caused Another to Burn Out

IT HAS been said that a little knowledge is a dangerous thing. This proved to be the case in one instance where trouble was experienced in the field coils of a two-pole motor. One of the field coils burned out and was rewound and the motor put back into service with the new coil. In a few weeks the new coil was roasted out and had to be rewound. Before putting the motor into service after the second burnout I was called into the plant to find out what was causing the trouble.

After hearing the history of the case, I decided that the apparently good coil was short-circuited. To check this, the two field coils in series were connected to the line as in the figure and a lamp was connected to the terminals of one coil and then those of the other. The lamp showed full brilliancy when connected to the coil that had been rewound, but did not even glow when connected to the other coil.

Obtaining no light across the coil that had not given any trouble showed this coil to be short-circuited, which allowed practically full voltage to be applied to the other coil. Full voltage on one coil would double the current through it and quadruple the heat that the coil must dissipate, thus accounting for the excessive heating. When the defective coil was opened, the insulation was



found broken down between the inside lead and one of the outside turns. This was repaired and the motor put into service, after which the temperature of the field coil remained normal. M. W. MORGAN.

Chicago, Ill.

Compressed Air and Vacuum From One Machine

IN AN industrial plant, a vacuum was needed for a new process. There was no vacuum pump on the job, but a good two-stage air compressor that provided compressed air for gas engine starting was available, so the vacuum line was connected to the intake of the low-pressure cylinder of this machine.

This worked fine as far as vacuum was concerned, but there came a time when compressed air and vacuum were needed at the same time. The air needed was for blowing and did not necessarily need to be at high pressure.

There was a safety valve between the two stages. The engineer simply removed it, and the high-pressure cylinder furnished the required air, while the low-pressure cylinder still maintained the vacuum, thus using both cylinders single stage. EARL PAGETT.

Coffeyville, Kansas.

A Stitch in Time Saves an Engine

A LUBRICATION engineer who visits all the plants to which he sells oil makes a practice of noting the running of the engines. He asks about trouble and their remedies, then passes the information along to the rest of his operating friends.

One of his hobbies is to place his hand on an engine crankcase and note the temperature. On a visit to a plant containing a large 4-cycle engine he placed his hand on the engine and noted it was excessively hot. He asked the engineer the reason. The only explanation was that "something was wrong with the oil." He took a sample from the crankcase in for analysis. The report came back that the oil contained 28 per cent fuel oil. He at once phoned the chief, told him of the report and recommended replacing the oil in the case. The operator then looked for the fuel line leak. This engine has the cam shaft on the side of the cylinders, about level with the heads. All shaft bearings and cams are oiled from the engine's oil circulating pump, and oil drippings are caught in a trough below the cam shaft. A small fuel line in the bottom of this trough was found to be cracked at a coupling, allowing fuel oil to drip into the trough and return to the crankcase with the lube oil.

This engineer's habit of noting these things probably saved the power company a bad crankcase explosion and a set of burned-out bearings.

Walthill, Neb. WM. W. DINGWALL.

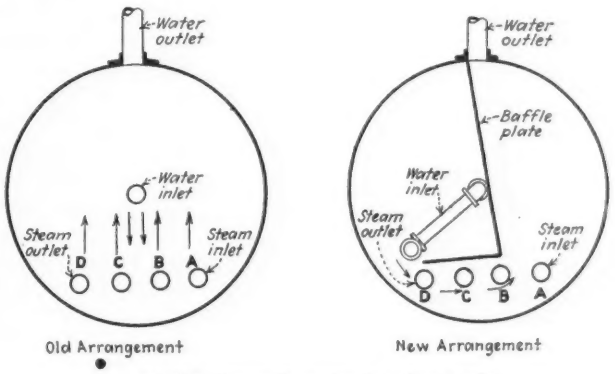
Improving Operation of Water Heater

THE changes here described produced an increase of 15 deg. in the outgoing water temperature and an increase of about 20 per cent in the capacity of our hot water tank heater and are applicable to any tank where the steam coil is made up of straight pipe and return bends.

As shown in the sketch, water entered the tank at the center of one of the heads and flowed by gravity to the bottom, meeting some resistance from the upward movement of hot water rising from the steam coil. This arrangement also had the effect of giving a lower temperature at the water outlet than existed at the point where the water left the steam coil surface, as the hot water from the end of the coil nearest the tank-head inlet had to pass through a blanket of cold water in order to reach the outlet. Another defect of the old arrangement was that with a coil of four longitudinal pipes, steam inlet at *A* and drip at *D*, all condensation found in *A*, *B* and *C* had to pass through pipe *D*, thus greatly reducing the heat transmission of that part of the coil due to the water film.

The first change made was a new method of introducing cold water into the tank. The cold water pipe, which came flush with the inside surface of the head, was extended by means of nipples, elbows and pipe so that the cold water was sprayed directly against pipe *D* for approximately its entire length. This arrangement, due to creating an increase in the temperature difference, made pipe *D* as effective as the others and was mainly responsible for the increase in capacity. Hot water rising from the remainder of the coil is no longer blanketed by incoming cold water, thus the increase in outgoing water temperature is realized.

It was then decided to place the baffle as shown, in order to provide a positive circulation of water and thus



Section through water heating tank

insure that the water would sweep against the entire surface of the steam coil. It was found possible to operate with a reduced steam pressure on the coil as the water was then heated to within a few degrees of the steam temperature. Formerly at peak load, the high steam pressure used on the coil gave such a high condensate temperature leaving the coil that considerable vapor was lost by flashing. The new arrangement gave at all times a condensate temperature below 212 deg.

Further experimenting proved to us that the amount of hot water used by tenants in the building decreased in proportion to the increased outlet temperature. This is due to the fact that for lavatory or bath use, increased temperature forces the use of cold water for dilution and eliminates to a great extent the practice of allowing water from the hot water tap to run to waste a few seconds each time a faucet is opened, in order to get hotter water.

Springfield, Mass. A. F. SHEEHAN.

Protecting Three-phase Motors Against Single-phase Operation

THE SHORT article on page 884 of *Power* for June 14 contains statements which are questionable. Mr. Glen says that the safe current for a 40-deg. motor is 115 per cent full-load amperes and that a fuse rated 125 per cent of this would provide ample protection against single-phase operation. Now, 125 per cent of 115 per cent is 144 per cent of motor amperes, and as the fuse will carry about 10 per cent more than this continuously, then the motor running 3-phase is permitted to draw 158 per cent rated amperes or about 50 per cent overload in horsepower.

Supposing the room temperature were 35 or 40 deg. C., what would the motor temperature be at 158 per cent amperes? The table gives some figures from test data on two motors operating 3-phase, both 40-deg. C. duty ratings. One has only 3-deg. margin at full load, while the other has 13 deg.

LOAD-TEST DATA FROM THREE-PHASE, 40-DEG. CONTINUOUS-DUTY RATED MOTORS

Horse-power	Speed, R.p.m.	Per cent full load..	100	115	125	140	150
50	1,800	Deg. C. Rise.....	27	37.5	45	62.5	75
50	1,200	Deg. C. Rise.....	37	46	58	75	..

The first motor might stand up at 150 per cent load with ordinary room temperatures, but the second would be rather hot.

Mr. Glen suggests protecting a 55-deg. motor, rated at 50 amp., by a 60-amp. fuse which will carry 66 amp. or 132 per cent of rated motor current. Supposing it was a 55-deg. enclosed rating, what will happen if 30 per cent overload is carried for any length of time, even at a normal room temperature? Those who have designed 55-deg. enclosed motors could tell. The statement is made that a 3-phase motor takes 1.7 times normal current for the same output when running single phase. 1.7 times 50 is 85 amp., which will blow a 60-amp. fuse. Suppose the motor is delta connected and the single-phase current is only 65 amp., which the fuse will carry. The motor will then be left on the line to overheat. H. WILSON.

Toronto, Ont.

CURRENT COMMENT

Continuous Blowdown

THE article by C. F. Rogers of Brooklyn (*Power*, July—page 34) concerning the apparent versus actual heat recovery obtainable by continuous blowdown is very pertinent. There are undoubtedly scores of continuous blowdown installations in the United States which in themselves yield an appreciable savings in heat, while, if the plant heat balance were carefully considered, it would be found that the equivalent heat utilized in the absence of continuous blowdown was lost.

As Mr. Rogers states, continuous blowdown plays an important part in maintaining properly balanced boiler water conditions, but equally important is the necessity of reclaiming the heat, if possible, so that the saving effected is real and not just apparent.

The examples that could be presented are numerous and diverse. Builders of continuous blowdown equipment should consider every angle of the heat recovery phase as well as the boiler water phase.

Elgin, Ill. E. F. HECKEL,
Elgin Softener Corp.

Circulating Pipe Connection On Scotch-Type Boiler

THE FIRST article on page 926 of the June 21 number of *Power* has to do with water circulation in Scotch boilers and shows a device which I believe will not produce the circulation intended.

The defect in the device shown is that the portion of the circulation pipe *above the water line* is empty and will stay empty. It is evident that as long as this pipe is empty, no circulation can occur.

If the circulation pipe is filled by opening the blow-off valve, which is then shut to retain the water the circulation, if any, will be the reverse of that desired. The exposed pipe will radiate heat, cooling off its contained water until its greater specific gravity causes it to re-enter the boiler at the bottom.

Circulation may be induced in Scotch and in locomotive type boilers by equipping them for thermo-syphonic circulation in which gravity is the activating power, and its application is kept within water level limits.

Chicago, Ill. C. A. SELEY.

Connecting Alternating-Current Generators in Parallel

ON PAGE 910 of the June 21 number of *Power* there appeared a short paragraph containing the sentence "To put the incoming machine in service with a minimum of disturbance, it should be running slightly faster, which will be indicated by the synchroscope pointer turning very slowly in the fast direction." This statement does

not present the entire case. If the generator is synchronized and connected to the power station bus properly, a minimum amount of disturbance, or none at all, will result whether the machine is running slightly faster or slower. The best method to use is to have the generator gradually accelerating in speed and running slightly slower than the speed equivalent to the frequency of the bus or to have the machine slowly decreasing in speed and running slightly faster than the speed equivalent to the frequency of the bus.

Using either method, attempts should be made to have the generator's oil switch close just before exact synchronism is reached. In this way, the power system connected to the bus will pull the machine into exact step with it. Because the system is comparatively larger than the single generator, the resulting surge is better absorbed. It is humanly impossible to have the oil switch close at the exact point of synchronism every time a generator is connected to the power station, though it is best, of course, to do so. The options left are to close the oil switch immediately before or after exact synchronism. The former is the best choice because less disturbance will be caused when the oil switch is closed as the machine is coming into synchronism than if it has just passed that point. S. EIN.

Hammond, Ind.

Fuel Injection Systems Work on Variable-Speed Diesels

IN THE June 21 number of *Power* I read with interest the article of Alan Craigon entitled "Metering and Injection in High-Speed Diesels." Mr. Craigon has advanced certain statements about fuel injection problems which do not conform with modern fuel injection systems or recent investigations of well-known authorities.

The conclusions of Mr. Craigon relative to the reasons for the final compression pressure and temperature at slow speeds are incorrect. The lower compression temperature at slow speeds is due to increased heat losses to the cooling water, not to the varying rate of work. It is also well known that the volumetric efficiency of the engine at slow speed is greater than at top speed. Therefore, taking into consideration other effects, such as valve timing and cooling, the compression-end pressure remains about the same throughout the speed range. Authorities like Ricardo and Dr. Boerlage found that the higher the compression end pressure is in a diesel engine the smoother it runs at variable speeds. It is also the writer's experience that supercharged engines run smoother at variable speeds and loads than ordinary engines.

Mr. Craigon is right in his confirmation that the key to the problem of variable-speed diesel engines lies in the fuel injection system, but he was too quick in condemning existing fuel injection systems. The writer has been engaged for years in diesel engine development work and now represents one manufacturer of fuel pumps and injectors. He, therefore, can safely state that Mr. Craigon's remarks about poor fuel pulverization are entirely contrary to modern practice. It seems that the fuel system Mr. Craigon has experimented with must be of poor design and workmanship. The properly designed jerk pump, in connection with a properly designed spring-loaded injector, fulfills all the requirements of a smooth operating variable-speed diesel engine. I am positive that had Mr. Craigon used a spring-loaded needle valve type injector with spring pressure properly determined in accordance with the speed range and the cam contour of a fuel pump designed for variable-speed operation, he would have had no trouble with atomization at any speed.

Chattering of the needle valve will occur with spring-loaded needle-valve type injectors only if nozzle orifices, pump plunger velocity and diameter of the needle valve are not properly determined. If the pump plunger velocity is too low for the nozzle orifices, the needle valve will seat several times during injection. The same will happen with too large needle valves for the orifice size, especially when the needle lift is not limited or is too great. With properly harmonized orifices, needle-valve dimensions and pump plunger velocities, there is no chattering in the fuel injectors. Not only stroboscopic and other kinds of reliable recordings but also a number of successful high-speed diesels now in operation substantiate this statement. The pressure drop at the opening of the needle valve will be hardly perceptible even with sensitive indicators, if the requirements as stated above are adhered to. Modern needles, weighing about an ounce, will not produce bouncing and will stay open when the oil pressure reaches its pre-determined value and stay closed when the pressure is released.

In the last paragraph of his article Mr. Craigon states that only constant-velocity spraying will save the variable-speed diesel from premature death, but he fails to give an explanation of how such constant-velocity spraying can be applied successfully to a variable-speed engine with fixed nozzle orifices.

New York City. NICHOLAS FODOR.

"Smokeless" or Smoking Furnaces?

A SO-CALLED "smokeless furnace" was installed a number of years ago in a Chicago factory plant. One boiler was equipped and there was such a marked decrease in the smoke that it was decided to equip the other boiler. The two boilers were as near alike in all particulars as it was possible for two boilers to be. When the second furnace was installed and fired no effect whatever was noted upon the smoke. The furnace was rebuilt and the position of the arches was changed. Other things were done but the second furnace continued to smoke while the first one performed satisfactorily. This continued for about a month when, the second furnace suddenly stopped smoking and the first one commenced. Regularly thereafter at intervals of about thirty days these two perverse furnaces would swap the responsibility for producing smoke. They never smoked socially together. One always behaved while the other was smoking. The contractor who had installed the furnaces was unable to make collection for either one of them and, finally, in despair, removed both of them. Find the "key log" in that particular "jam."

Johnson City, Tenn. WALTER S. PEUGEOT.

Kneeland Street Plant

COLLECTS FLUE DUST

After two and one-half years of development work, the Edison Electric Illuminating Company of Boston has succeeded in removing ninety-five per cent of the solids from flue gases by an improved scrubbing process*

SINCE it is located adjacent to the business district of the City of Boston, operation of the Kneeland Street boiler plant has been a serious concern to the Edison Electric Illuminating Company from the point of view of successful elimination of solids from the stack discharge. For a period now of two and one-half years the power company has been seeking a method, within economic range, which would successfully remove the possibility of complaint from the district because of dust, soot or ash discharge.

The first step was taken with the decision that the Pease-Anthony gas scrubber offered the best possibilities. As a result, a model scrubber 4 ft. in diameter by 8 ft. high was built and tested on the stoker-fired boilers at the company's Edgar Station in 1929.

The first design, Fig. 1, consisted essentially of a brick-lined chamber with a tangential gas inlet on one side of the shell near the bottom and a number of rotating disk atomizers delivering a fine water spray through which the gas had to pass.

The second step was to discontinue rotation of the atomizers and to substitute stationary spray nozzles, as in Fig. 2.

The third form of scrubber is shown by Fig. 3 and consists essentially of the scrubber arrangement used in Fig. 1, except that the discharge from the bottom of the scrubber chamber is to a Callow settling tank for the purpose of separating the solids from the scrubbing water, thus providing means for reclaiming the latter for recirculation.

As the result of experimental work with arrangements 1, 2 and 3, the new 350,000-lb. per hr. boiler installed during the past year has been fitted with the latest design of scrubbers, Fig. 4. These are larger than before, the inside pipes coming from the sides of the scrubber shells having been eliminated and a more efficient connection between the bottom of the shell and the Callow settling cones worked out.

Fig. 5 shows a cross-section of the steam heating station with the gas scrubbers in place.

Throughout these experiments a number of important matters were determined. For convenience these are listed as follows:

1. Any advantages to be gained by the use of rotating disk arm atomizers were offset by the disadvantages of having moving parts inside the scrubber chambers.

2. After the decision to use stationary spray nozzles, great difficulty was encountered in trying to keep them from clogging up and in maintaining them against the high rate of corrosion resulting from the sulphur content of the flue gases. All parts coming into contact with the wash water corroded severely.

3. About twenty different corrosion-resisting metals and alloys were tested, and most proved unsuitable for the service. Elcomet K alloy was used for such interior parts as spray nozzles, braces and recirculating pumps with fairly good effect. Scrubber shells were constructed of steel plate and lined with Cheesman Elliott plastic stack lining and acid-proof brick set in acid-proof cement. Manifolds inside the shells were made of heavy cast iron, with full cognizance of the fact that they

*This article was prepared from information supplied by I. E. Moultrop, chief engineer and supt., Construction Bureau.

Fig. 1

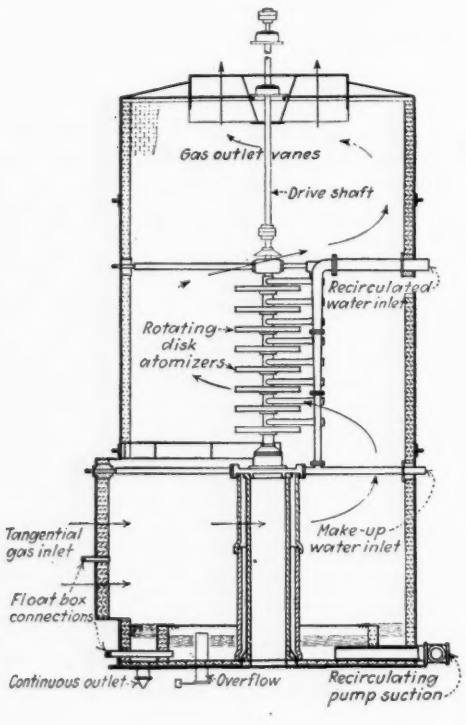


Fig. 2

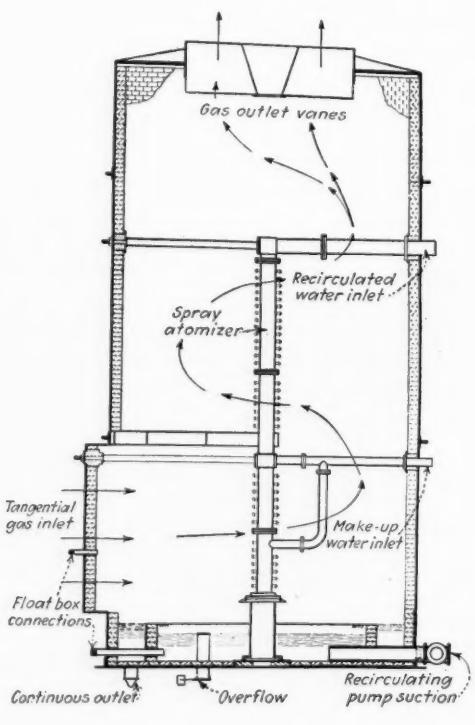
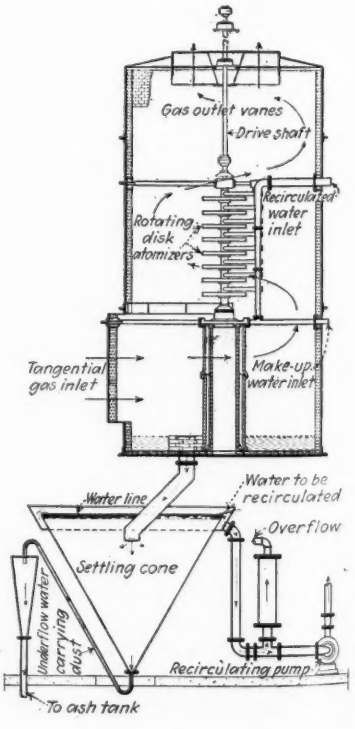


Fig. 3



would probably require frequent replacing.

4. Rubber-lined pipe was used for scrubber drains, because of the success of this material under somewhat comparable conditions by the Commonwealth Edison Company of Chicago.

5. The Elcomet K alloy did not prove satisfactory for the service, due to intercrystalline corrosion.

6. Other materials tried and not found suitable were: Bakelite, glyptal reinforced with asbestos fabric, brass Hastelloy C, semi-soft rubber, cast-iron and copper spray nozzles.

7. The only successful material for the construction of the spray nozzles has been heat-treated lava.

8. The cast-iron manifolds in the scrubbers cut through very rapidly where struck by the wash water or at points where leaks occurred. Except for this, disintegration of the metal was quite slow and occurred from the iron going into solution and leaving behind it a porous layer of graphite and silica. This forms a protective coating for the remaining metal so the heavy cast-iron manifolds are expected to last about a year before replacement.

9. Illium pump impellers replaced those made of Elcomet K and have lasted several months.

Brick-Lined Shells

10. The brick-lined shells are giving satisfactory service, although it is not known whether any corrosion is going on between the brick lining and the shell metal.

11. The water supply is kept at a minimum by recirculating the scrubber water and furnishing make-up from the back wash, also rinse water from the zeolite softeners in the station, as well as from the continuous blowdown from the boilers. If these water supplies are not sufficient the balance is made up from the city mains.

12. The spray water outlet at the bottom of the scrubber carries the dust with it into a Callow settling type tank or cone. This dewaters the dust and returns the major part of the water to a recirculating system from whence it is delivered again to the scrubber. A tap at the bottom of the cone carries the thick liquid containing the dust discharge to a secondary settling or ash tank. The Callow settler delivers the water to the recirculating system with a content of from 0.02 to 0.15 per cent of solids by weight. Experiments are going on by which it is believed this content will be reduced to 0.06 or 0.08 per cent maximum. This is expected to increase the life of the spray nozzles materially.

13. At present the metal of the Callow cones is protected with rubber paint, but experience indicates that rubber or some other corrosion-proof material may have to be used.

14. Gases leaving scrubber are completely saturated with water vapor.

15. To prevent condensation in the induced-draft fan breeching and chimney, with consequent danger of corrosion, hot air from the air heater outlet is introduced at the fan suction in sufficient quantity to reduce the relative humidity of the gas leaving the scrubbers. To further reduce the likelihood of condensation, the induced draft fan and breeching above the boiler plant roof are insulated.

Careful Tests Made

16. Careful tests have been made by George Orrok, Jr., operating engineer of the station. Gas samples entering and leaving the scrubbers were measured by 16-point simultaneous traverses of the ducts. A sampling tube was maintained, facing into the gas flow, and samples were withdrawn by a vacuum pump at a rate maintaining the same velocity in the sampling tube as in the duct. Dust was filtered out of gas samples with Alundum crucible filters. Tests indicate scrubbers as now operating, will remove approximately 95 per cent of the fly ash in flue gas discharge from the boiler during the year. No claim of extreme precision is made in reporting this result as it is well known that present methods are susceptible to error.

17. A greater percentage of fly ash is fused in the furnace when the boiler operates at high loads than at low. Low loads result in very little ash collection in the furnace.

18. The total acidity of the recirculated water is found practically constant at all loads. It varies from 0.1 to 0.3 per cent, is mostly sulphuric and contains traces of sulphurous, hydrochloric, nitric and hypochlorous acids. These traces of acids, other than sulphuric, are regarded as principal causes of heavy corrosion of parts with which scrubbing water contacts.

19. The scrubbers collect part of the unburned carbon in the gases, as well as fly ash, the former being present as coke.

To Catch Acids in Gases

20. Investigation by the University of Illinois is now under way with the idea of catching various acids in the gases by using suitable chemicals in the scrubber water.

21. At 100 diameters magnification, dust appears as small spherical particles with other extremely fine particles, first thought to be broken silica spheres. At 400 diameters these finer parts were found to be almost all of spherical shape. A large part of the dust caught appears to be 3 to 5 microns in diameter. Considering that a particle just passing a 325 mesh sieve is 43 microns in diameter, an idea of the extreme fineness of a large part of the dust is obtained.

22. Another problem requiring further study and experimentation is the dehydration of the dust to a point suited to handling. Present ash tanks are 6 ft. square by 20 ft. high and the bottom discharge comes out fairly dry. After settling and decanting, the top layer is almost satisfactorily dry, but between these two the material is very sloppy, and to handle it is a messy and difficult job.

Although scrubbers installed with the first two boilers have operated three and one-half months continuously, it is not felt that they have reached final development or higest possible efficiency. Examination shows however, that the major problems have been solved. Other experimental work is progressing steadily.

Fig. 4

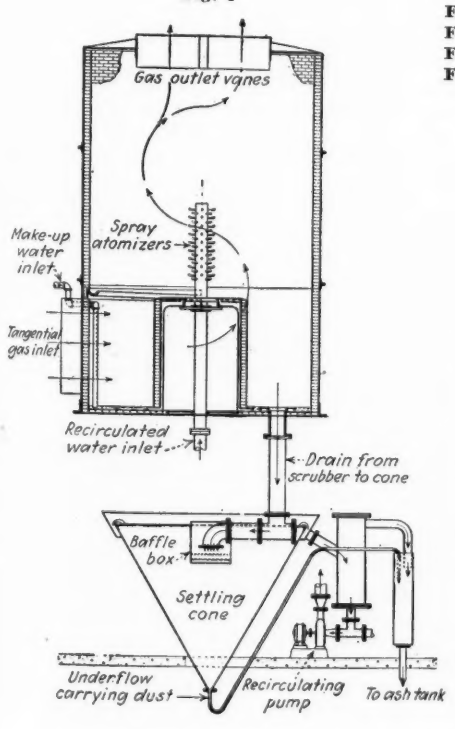
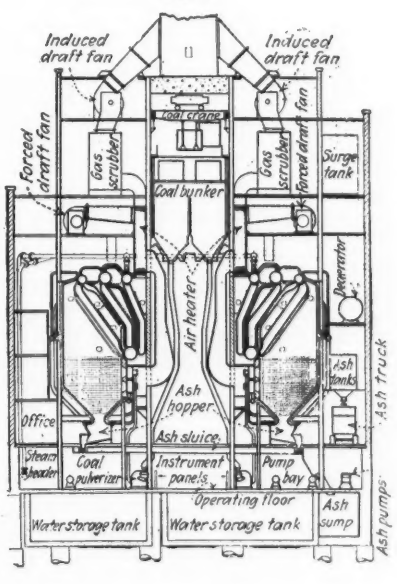


Fig. 1—First design; rotating atomizers
Fig. 2—Stationary atomizers replace rotating
Fig. 3—Settling tank added
Fig. 4—Latest design of scrubber
Fig. 5—Present gas scrubbers in place

Fig. 5



Care for The Steam Gage

By JAMES F. HOBART*

A STEAM gage, like any other mechanical device, must be given a little care now and then in order to perform its work properly.

The pressure gage should be properly connected to the vessel or apparatus with adequate protection against live steam reaching the Bourdon tube. This is usually done by placing a "goose neck" in the pipe connection close to the gage, or by arranging an inverted syphon, consisting of a few fittings and short pieces of pipe, that will retain some condensation whether the steam pressure is on or off.

Whenever a gage is periodically disconnected for care and inspection, it is well to make sure that mud deposits do not clog the entrance to the tube or the tube itself. A good way to clean out the tube and the passage is to procure a clean squirt can, fill it with clean water, insert the end of the spout in the passage leading to the Bourdon tube, then, using the oil can as a force pump, to squirt water into the passage with all the force possible.

The tube should be inspected closely to make sure that it does not leak, or that it has not been distorted by freezing or by the presence of high-pressure live steam. When distortion or leakage is found, discard the gage or send it to the maker for a new tube.

Clean All Over

Clean the inside of the gage case, also the glass cover, and see that it fits well and closely enough to exclude dust. However, the case should not be sealed airtight, as the heating and cooling of the air inside the case necessitates a small vent hole for equalization of the slight changes of pressure inside.

A gage should never be operated with a broken glass cover or with no glass at all. Such operation permits dirt to enter the case and interfere with the proper operation of the gage. Each engineer should possess a tool for cutting circular glass disks, in order that a new disk may be cut from a pane of glass whenever necessary. This can be done readily with the standard cutter in the following manner:

Obtain a piece of soft wood, about $\frac{3}{8}$-in. thick and somewhat larger than the glass to be cut. Find the center of the thin board, and around that center scribe a circle equal to the diameter of the glass required, plus the thickness of the cutter at the point where it will come against the templet. Next, carefully cut out the wood inside of the circle, taking care not to cut

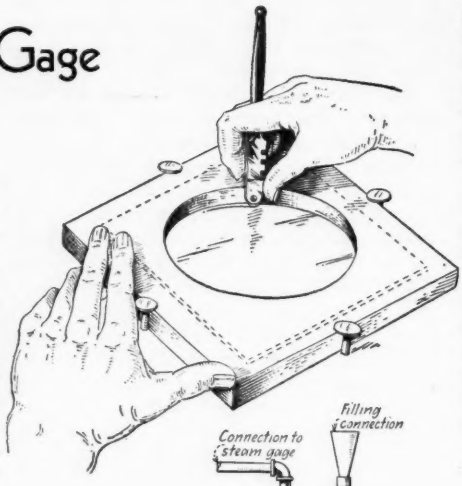


Fig. 1—Templet for cutting circular gage glasses

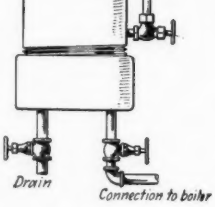


Fig. 2 — Reservoir for non-freezing liquid used when gage is located out of doors

over the circle and to finish the cut edge smoothly.

Having finished the templet, place it over the glass, laid flat on a smooth bench or board. Put the templet in position and fasten it by driving three or four small nails through it outside of the glass and a short distance into the board beneath. Next, place the glass cutter in position as shown and cut around the inner circumference. After cutting once around the circle, remove the templet, turn the glass upside down, and with the handle end of the glass cutter, tap lightly above the marked circle on the under side of the glass. The edge of the glass disk can be made smooth by using a grinding stone with plenty of water.

Generally, before a gage can be opened for cleaning or adjustment, it is necessary to remove the "pointer." This should not be pried off with a screw driver as is frequently done, for such action is almost sure to bend the shaft or the housing in which the shaft is journaled. Every engineer should have a standard "gage jack." If one is not available, however, a small pair of pliers pushed under the hand, deflecting the cover plate some if necessary, may be used to grasp the shaft and prevent its turning. The hand is then grasped with the fingers on both sides of the shaft and turned back and forth to loosen it so it may be pulled off.

Usually it will be found necessary to take down the indicating mechanism and to clean the pinions and bearing holes. Sometimes the pinions and housings will be found "gummed" with dried grease. Machine or cylinder oil should not be used on a steam gage, clock oil being the best lubricant. In case the gage is located close to a boiler where the temperature is very high, oiling should be omitted altogether, and powdered graphite used.

After the gage has been reassembled it should be tested for accuracy by comparison with a gage known to be correct. Small, accurate pressure gages, about 4 in. in diameter, are not expensive and are quite suitable for testing purposes. A gage used for this purpose should, however, be checked frequently with a standard gage. Each time the boiler inspector comes around, he will gladly check your master gage.

In order to compare the steam gage in hand with the little master gage, it will be necessary to have at hand some means of applying pressure to both gages at the same time. The best and most satisfactory way of comparing two gages is by the use of a small, hand-operated pump to which both gages are attached. However, there are several ways of comparing pressure gages without the use of a test pump. Having connected each gage to a section of steam pipe, that pipe may be connected through a suitable control valve, with a boiler under pressure, and pressure applied to both gages as required.

The gages should be closely compared while pressure is ascending, also, when pressure is descending, or decreasing, and adjustment made to make it indicate correctly throughout its range. In case there is no lever adjustment for calibrating the gage, or the pointer cannot be made to run up or down properly, then the best arrangement possible of the lever should be made. The pointer of the gage should be set to indicate properly the pressure at which it is expected to be used.

In some plants two or more pressure gages may be located in different parts of the plant and connected to the same steam vessel. Care should be taken to see that all gages record the same pressure after making the necessary allowance for any head of water on the gage in cases where it is located several feet below the point of pressure measurement. It may be advisable to reset the hand so that the static head will be compensated.

Frostproofing

If a pressure gage has to be used outside in locations where there is danger of freezing, it may be frostproofed by an arrangement similar to that shown by Fig. 2. By means of this appliance, steam does not pass outside of the boiler room, but boiler pressure is transmitted to the outdoor gage by a non-freezing liquid, usually a non-congealing oil, or, as may be the case, ordinary kerosene.

The appliance shown consists of an oil reservoir made of a piece of 4 in. pipe about 10 or 12 in. long. It is shown fitted with a gage glass (not absolutely necessary for operation).

*The author who has been a constant reader of *Power* for many years and has the distinction of being our oldest and probably only blind contributor. Mr. Hobart types his own manuscripts on his typewriter.—Editor.

READERS' PROBLEMS

BALANCE COILS WOULD NOT GIVE PROPER VOLTAGE—*Some time ago I had to supply a 110-volt lighting circuit from a 440-volt line. Two 220- to 110-volt balance coils were available. These were connected in series across the 440-volt line and the lamp circuit taken off as indicated in the diagram. Before the lamps were connected the voltage was equal between the different taps on the balance coils, but, as soon as the lamps were switched on the voltage decreased on their circuit and increased on the other section of the balance coils. Can these coils be connected to operate satisfactorily?* A. J.

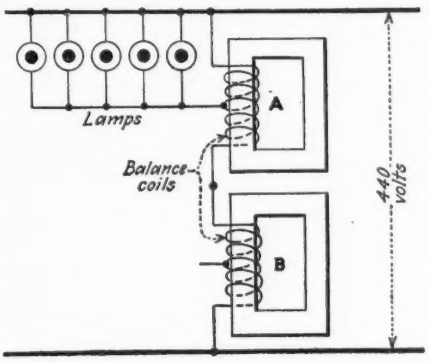


Diagram of balance-coil and lamp

The coils cannot be connected to give a balanced voltage, because the two coils have separate magnetic circuits. As soon as the lamps were connected, balance coil *A* tended to increase its current flow. As this coil is in series with coil *B* the current must also increase in that coil. Increasing the current through coil *B* would increase the flux in its core iron and increase the voltage in the coil. As a result the voltage across coil *A* must decrease.

For satisfactory operation the coils must all be on one core. As a temporary expedient the lamps could be distributed equally on the two coils, but to use this arrangement all the lamps will have to be switched on and off at the same time. This could be done by a two-pole switch connecting the balance coils to the line.

▼ ▼ ▼

Cleaning Radiator Orifices

Answers to question of July 14

OUR HEATING system has just completed its first full season of operation. All of the radiators are equipped with orifices installed at the radiator valve union. As there was considerable pipe scale in the system, a few of these orifices became clogged. Is it advisable to inspect all of the orifices before the next heating season and, if so, what is the best method of cleaning them? H. MCG.

Cleans Orifices When System is Operating

IT IS best to clean out radiator orifices when the plant is in operation. The radiator valve should be closed, disconnected at the union, and if the orifice is of the insertable type, it should be removed. The valve should then be opened to blow out the loose sediment while at the same time tapping the pipe with a hammer. If this is a vacumn system using thermostatic traps, these traps should be cleaned at the same time. Take out the thermostatic element and clean with alcohol or gasoline. When the trap is disconnected at the union to the radiator the valve should be opened and the radiator blown out. Then replace the orifice. W. R. T.

Wichita, Kan.

Uses Muriatic Acid

I RECOMMEND strongly the inspection of all radiator orifices, as this is a job we have just completed in our hotels. We worked over every radiator orifice in the building, and on some radiators the orifices were half clogged with scale. These were easily cleaned by immersion in a 50 per cent solution of muriatic acid followed by thorough rinsing in cold water. The value of inspecting all the radiators lies in the chance that H. McG. may find, as we found, that some radiators have too large an orifice for the size of the radiator, while other large radiators have too small an orifice. This naturally causes an unbalanced heating system. If the questioner finds a few clogged orifices, it will be better to take no chances and inspect them all.

Wichita Falls, Tex. A. E. TENLEY.

Flow Areas Should Not Be Changed

SINCE the service and satisfaction obtained from an orifice-equipped heating system depends upon maintaining the balance, any method of cleaning used should not change the flow areas through the orifices or their cross-sectional contour. Where a heating system has been operated only one heating season it is often advisable to go over the entire system if there is indication of need for inspecting any considerable number of the orifices. If the locations of the clogged or partly obstructed orifices are known it is probable that inspection of these and a sufficient number of the others to obtain a fair idea of the condition of the orifices generally will suffice. Such an inspection will indicate whether a complete inspection is required.

The method of cleaning any orifices inspected would depend upon the nature of the substance found to be obstructing them. The use of an instrument which would scratch or cut into the orifice should be considered as a last resort only.

Where the scale is due to a calcium deposit we have found that if immediately wiped with a rag upon removal from the system the orifice plate can be throughly and rather easily cleaned. If the orifices are allowed to dry any length of time the scale will harden, and to clean them without damage requires the use of a rag saturated with oil, or wiping with a rag after there has been immersion in oil for a period of time. A light machine oil is satisfactory for this, or a mixture of machine oil and kerosene will do the job.

With a system which has operated only one heating season the material causing the difficulty is more frequently found to be formed from the excess of pipe "dope." This material is more easily removed by wiping off with a rag saturated in benzol, or preferably washing in benzol using a small paint brush or some other suitable bristle brush. If the orifices are in the nipples a brush such as a chemist uses to wash his test tubes will serve admirably. These methods have been used with success in many localities.

D. N. CROSTHWAIT, JR.

Marshalltown, Ia.

A Question for Our Readers

WE HAVE a 150-hp., 1,150-r.p.m. 440-volt, wound-rotor induction motor driving a centrifugal pump. This motor has given trouble by running about 25 r.p.m. below its rated speed. A check on the speed of the generator shows that its frequency is correct. The motor is underloaded because the decrease in speed has caused a reduction in the pump's discharge. What are the possible causes of the motor's running below rated speed? M. L. K.

Suitable answers from readers will be paid for if space is available for their publication. Typewritten replies should preferably be double spaced.

THE ENGINEER'S BOOKSHELF

Power Plant Ownership

RECENT TECHNOLOGICAL DEVELOPMENT AND THE MUNICIPALLY OWNED POWER PLANT. *By Paul Jerome Raver, assistant professor of public utilities, Northwestern University School of Commerce. Published by the Institute for Economic Research, 337 E. Chicago Ave., Chicago, Ill. 1932. Paper; 7½x10 in.; 10 charts; 32 tables; 86 pages. Price $1.50.*

This is the fifth of a series of monographs that the Institute has published in an attempt to fill some of the obvious gaps in factual information on municipal power plants. These monographs have not been prepared with the idea of entering the controversy on municipally owned versus privately owned power plants, but to present facts that would provide either interest with material better to understand the problem. In this publication the growth and modernization of generating plants is sketched in terms of horsepower capacity and types of prime movers used. The data cover information for all plants in the United States for each year from 1903 to the close of 1930. One of the 32 tables gives the geographical distribution of municipal generating plants in existence on Dec. 30, 1930. On this date the eleven states in the West-North-Central and the West-South-Central groups contained almost half of the municipally owned generating plants in the United States.

Combustion

INDUSTRIAL GAS SERIES—COMBUSTION. *Published by the American Gas Association, 420 Lexington Ave., New York City, third edition. Paper; 9x12 in., 208 pages, 60 figures, 58 charts. Price $2.*

Although this book deals primarily with the combustion of gas it contains much data of general interest to industrial gas engineers. It is divided roughly into two parts, theoretical and practical, both considerably enlarged over previous editions.

Advanced theory is introduced in the chapters on chemistry of combustion, heat transfer and the design of atmospheric burners. There have been included rather complete tables of thermal data such as specific heat, latent heat of fusion and evaporation of solids and liquids, as well as hitherto unpublished thermal and physical data of metallic alloys.

Much useful information is given in the first two chapters on measurement of heat, pressure and gas flow, including viscosity data required in calculating pressure drop due to flow of gas in pipes.

The final chapter deals with a comparison of various fuels and is frankly written to provide the gas industry with an outline of the principal selling arguments and advantages of gas as a commercial fuel.

Following each of the seven chapters is a bibliography of the important works on the subjects dealt with in the chapter.

Entropy and Gas Engines

I-S DIAGRAMME FÜR VERBRENNUNGSGASE UND IHRE ANWENDUNG AUF DIE VERBRENNUNGSMASCHINE (Entropy—Heat Diagrams for Combustion Gases and their Application to Internal-Combustion Engines). *By Dr.-Ing. Walter Pflaum. Published by VDI-Verlag GMBH, Berlin NW 7, Dorotheenst. 40, Germany. DIN A 4, IV/45 pages with 69 illustrations, 3 numerical tables, and 17 diagrams on separate tables. Price 7.90 Marks (VDI-members 7.10 Marks).*

In steam-engine and refrigerating engineering, the entropy-heat diagrams (Mollier diagrams) have been used for this purpose for many years. The present treatise enables the extending of the advantages offered by such diagrams also to the design of internal-combustion engines and firing plants. These advantages are chiefly in the clear conception they convey of the thermo-dynamic processes, the simple manipulation, and rapid way of calculating, no matter how intricate the analytical relations may be if handled without the aid of the diagrams.

While the conbustion gases do not represent a homogeneous substance such as steam, the author has succeeded in covering the whole field of the solid, liquid and gaseous fuels with but a few diagrams. The entropy-heat diagrams are worked out on the basis of the latest specific-heat values and, moreover, take into account the dissociation of the steam and carbon dioxide contained in the combustion gases. To facilitate their use, auxiliary diagrams have been worked out for the amount of air required and for the combustion volume and combustion heat.

In the second part of the treatise, the "model processes", i.e. those of the best possible utilization of the available energy, are established for the various types of internal-combustion engines from the same point of view.

Numerical examples of calculations relating to internal-combustion engines and firing plants show how the entropy-heat diagrams may be used in designing such plants.

Hyperbolics

ELEMENTARY HYPERBOLICS (Two vols.). *By M. J. Gheury de Bray. Published by Crosby Lockwood & Son, Stationers' Hall Court, Ludgate Hill E. C., London, Eng.; 1932. Cloth 5x7½ in. 351 pages; Vol. I; 209 pages, Vol. II. Charts and tables. Price 7/6 per volume.*

In these two small volumes the author gives in his characteristically intriguing style a clear, interesting, and most valuable exposition of hyperbolic trigonometry, together with liberal demonstrations of the application of hyperbolic functions to engineering problems.

Vol. I, *Hyperbolic Functions of Real and Unreal Angles*—In the first part of this volume the various forms of vector operators are derived and their uses clearly explained with numerous illustrations. The second part presents the physical meaning of hyperbolic functions and their properties. In the third part, the meaning and graphical representation of complex hyperbolic angles are given, and lastly the use of hyperbolic tables is explained and illustrated by various examples.

Vol. II, *Applications of Hyperbolic Functions*—This volume is divided into two parts, both of which are devoted to the application of hyperbolic functions to physical problems. The first part applies hyperbolic functions to problems of navigation, the solution of equations, and problems in strength of materials. The second part propounds in logical form those fundamental laws of electricity from which the equations for the propagation of electric current along transmission lines under steady state conditions are derived in terms of hyperbolic expression—ROBIN BEACH

Professor of Electrical Engineering, Polytechnic Institute of Brooklyn (N.Y.)

Corrugated Pipes

THE FLEXIBILITY OF CORRUGATED PIPES UNDER LONGITUDINAL FORCES AND BENDING. By L. H. Donnell, research fellow in aeronautical structures, California Institute of Technology. A paper printed in the A.S.M.E. Transactions as APM-54-7—Pipes with circumferential corrugations are being used in expansion bends in steam lines and other applications where maximum bending flexibility is required. A "reduced modulus of elasticity" is derived in this paper by which corrugated pipes can be calculated as if they were smooth. This same modulus is then proposed for use in calculating bending of corrugated pipes.

A.S.M.E. Boiler Code Used for Hoover Dam Hydro Pipes

WHILE it is of wide interest that the United States Government, through the Department of the Interior Bureau of Reclamation, has awarded a $10,908,000 contract to the Babcock & Wilcox Company of New York City for the fabrication and installation at Hoover Dam, of what is probably the heaviest pipe yet made, other features of the contract are of special significance to the readers of *Power*.

Essentially the job will consist of four main headers, each leading from an intake tower, thence through tunnels to a point downstream of the power house. Two of the headers will be on the Arizona side of the Colorado River and two in the State of Nevada. All will be 30-ft. inside diameter, with plate thicknesses varying from 1¼ in. to a maximum of 2⅛ in. for the two upper lines and 2⅛ in. for the two lower lines. Four 13-ft. diameter penstock outlets are taken from each of these 30-ft. header sections, to carry the power water supply to the sixteen turbines in the power house.

Each 30-ft. header section has a 25-ft. diameter extension, with plate thickness varying from 1⅛ in. to 2⅜ in. The extensions from the two upper level headers each terminate in six 102-in. diameter valve conduits with reducing tapers for the connection of 84-in. needle control valves. Each of the two lower extensions terminates in a triple outlet wye with 25-ft. diameter inlet of 2⅜-in. plate and three 13-ft. by 1 5/16-in. plate outlets. These in turn each bifurcate to form outlet connections for a total of six 72-in. needle control valves.

The penstocks are 13-ft. diameter with plate thicknesses varying from 1 in. to 1 5/16 in.

There are about 55,000 tons of steel plate work involved. All is to be furnished complete of electric arc-welded construction and installed inside the tunnels, the two upper ones being 37 ft. and the two lower ones 50 ft. Girth joints, pinned or arc-welded, will be used. The maximum head on penstocks is 584 ft. and the maximum head on load regulating valve outlets is 563 ft.

Before submitting its tender, each bidder was required to make up and test models of not less than ⅛ scale, as to diameter and plate thickness, and to conform as nearly as commercially possible in scale dimensions for one 30-ft. by 13-ft. header penstock lateral and one 25-ft. by 13-ft. triple outlet wye for the lower control valves.

In writing the specifications for this pipe job and determining the practice to be used in its manufacture, the U. S. Reclamation Service regards the entire construction to be of such importance and magnitude as to warrant the adoption of the same requirements for workmanship and material that would normally be used in the highest grade of boilers. The steel plates are to conform to the standard specifications for boiler and firebox steel for stationary service as prepared by the A.S.T.M.

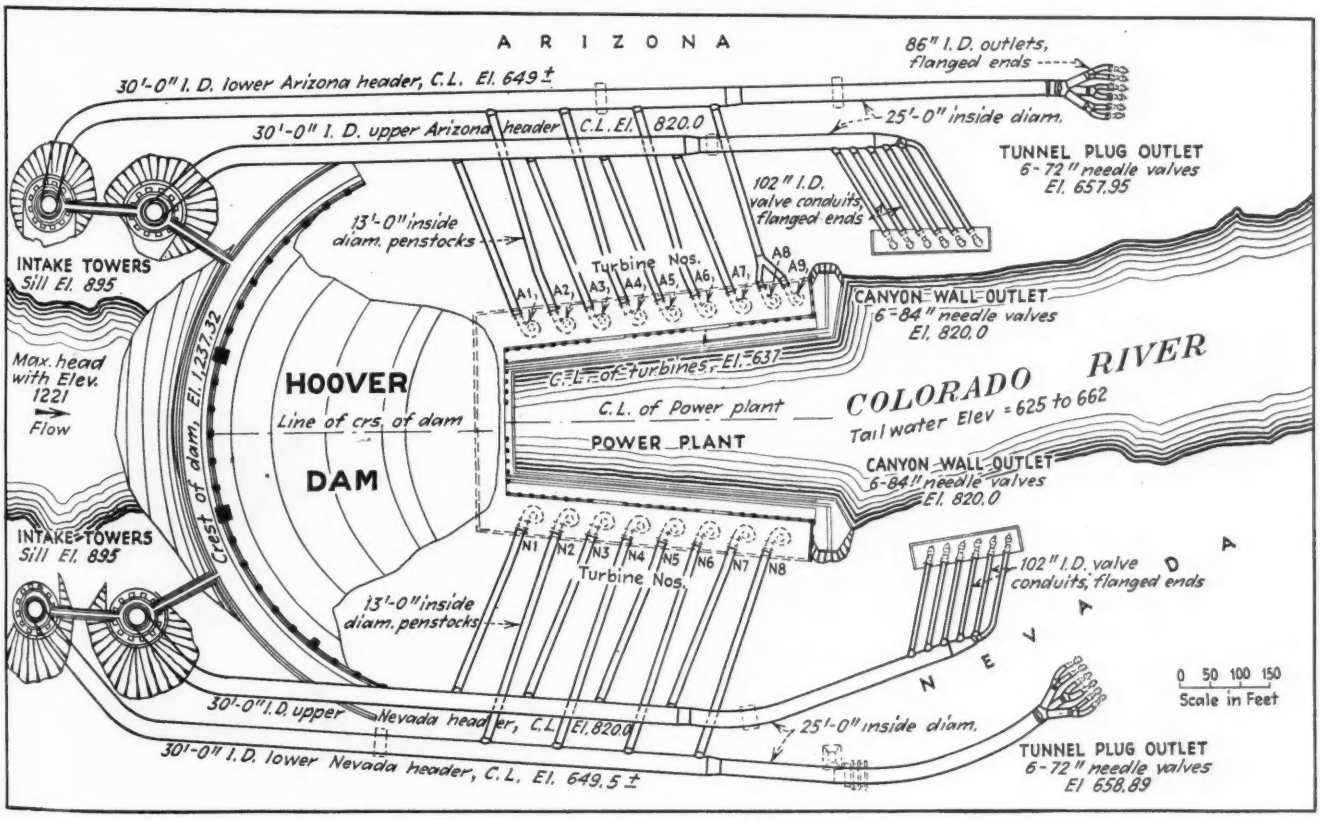
All welding is to conform to current rules for the fusion process of welding Class I—A.S.M.E. Boiler Construction Code for Unfired Pressure Vessels. Tensile strength of any welded joints shall be not less than 190 per cent of the yield strength of the plates.

The qualifications of the welders doing the work are required to meet the specifications of the A.S.M.E. Boiler Code. Physical tests, as well as x-ray pictures of the welds, are required as a part of the inspection process.

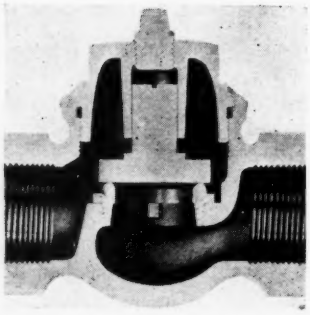
Circumferential joints may be welded and stress-relieved. In the joints of the single outside butt-strap or bell-and-spigot type, cold pinning is required for all plate thickness greater than 1 in. Hot-driven rivets not over 1⅛ in. in diameter may be used for all plate thickness of 1 in. or less, provided double riveting is used.

Where cold pins are used they are required to be ground for a body bound fit on a basis of 0.001 in. per inch of diameter, the material to be suitable for cold peening in the countersunk portion of the pin hole outside of the butt strap.

The entire job is of such size and the parts of such weight that shipment completely fabricated from the factory is impossible. A special fabricating plant will be erected on the site and will require approximately 1,500 hp. for its operation. An additional 200 hp. will be needed for field erection tools in the tunnels. On completion of assembly all four lines will be filled with water under static pressure to test for water tightness. No pressure test except normal working conditions is contemplated.



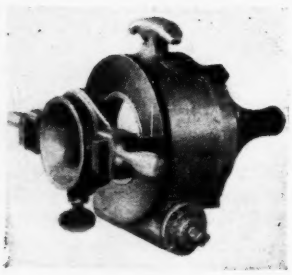
WHAT'S NEW IN PLANT EQUIPMENT



Check Valve with Renewable Parts

Seats and disks, of any desired material, are arranged to permit regrinding or refacing. Seat may be renewed without taking check from line. Disk ground by screwdriver inserted through top plugged hole, using cap as guide. Sizes ½-in. to 3-in.; working pressures 0 to 275 lb.

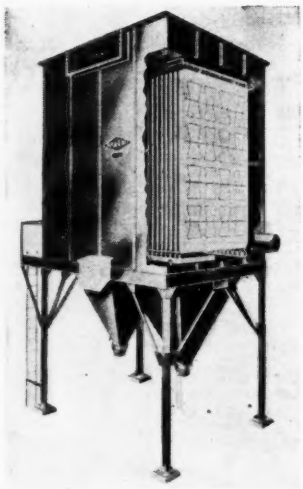
Bundy Steam Trap Co., Nashua, N. H.



Power Adapter for Pipe Threader

Steel, iron, brass, copper or cast-iron pipe from ¼ to 2 in. can be threaded with "Beaver" No. 17 adapter. Is a worm-driven diestock using interchangeable die heads. Operated by ¾-in. heavy-duty electric or compressed-air drill. Aluminum alloy construction; weight 17½ lb. Self-centering chuck at rear, grip at top, double-ended drive permits cutting either left- or right-hand threads with back-off by power.

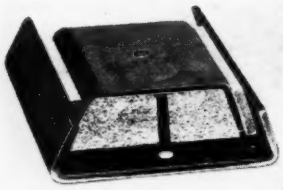
Borden Co., Warren, Ohio.



Framed-Bag Dust Collectors

Cloth filters are used in Blaw-Knox all-metal dust collectors. Simple wrapping type cloth bag seal uses only two bolts, no tacks, nails or screws. Claimed by maker that minimum of supplementary equipment is required, also lower weight per unit of capacity, special cleaning mechanism, accessibility, easy cloth changing, low erection cost, compactness and positive action. Company offers engineering service on dust collector problems.

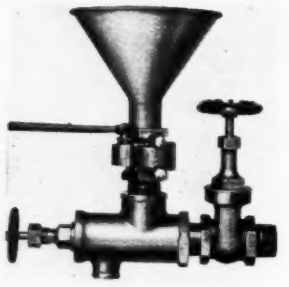
Blaw-Knox Co., Pittsburgh.



Vibration Isolator

"Seismo-Damper" consists of an arrangement whereby any isolating material inserted between upper and lower housings is preloaded by maker to proper point. Upper housing drilled and tapped for bolting to base or leg of machine.

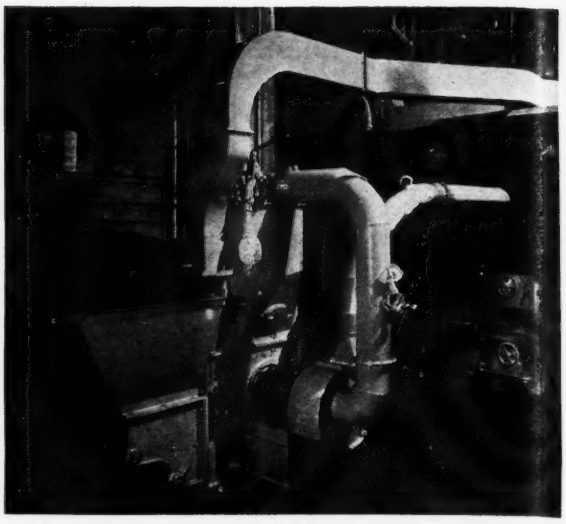
Korfund Co., 48-15 32nd Place, Long Island City, N. Y.



Condenser-Injector

"Wizard" condenser-injectors inject special sealing mixture into circulating water, claimed to stop leaks within five minutes. Sealing mixture claimed inexpensive and harmless. Injector itself claimed simple and inexpensive, with no moving parts. Recommended for use with salt detector light available from same maker. Claimed to increase boiler efficiency and reduce maintenance. Sealing compound placed in funnel top, then gate valve to injection pipe and steam valve opened in turn, followed by swing gate valve below funnel.

Condenser Service & Engineering Co., 310 Twelfth St., Hoboken, N. J.



Boiler Water Test Meter

Concentration of mineral salts in boiler waters can be tested with this unit, which has built-in thermometer scaled from 60-120 deg. F., permitting testing anywhere within that range. Built-in correction table coacts with thermometer; conversion table shows concentration in grains per U. S. gal. and parts per million. No calculations necessary.

E. Edelmann & Co., 2332 Logan Blvd., Chicago, Ill.

Special Heat Exchanger

Consists of four straight tubes bonded together mechanically by many closely spaced thin metallic plates. Tubes are expanded into holes in these plates. Return member connects each pair of tubes at one end. Other end consists of stationary head into which tubes are expanded, and which has inlet and outlet connections. Hot vapor or liquid passes through one set, colder liquid through other set, heat being passed by conduction through metal plates. Called G-R Tube-flo section, Type KC.

Griscom-Russell Co., 285 Madison Ave., New York City.

Small Unit Pulverizer

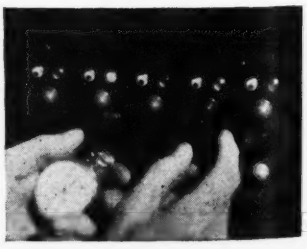
A-6 "Unipulvo" unit pulverizers, for handling bituminous coal screenings, pitch, lignite, or petroleum coke breeze in capacities from 200-750 lb. per hr. are self-contained and mounted on single bedplate. One 7½-hp. motor provides power for pulverizing and handling air. ⅓-hp. motor actuates fuel-feeding mechanism. Feeder of reciprocating-shoe type, adjustable. Rotor swing-hammer type mounted upon extension of motor shaft, with floating outboard bearing. Expansion chamber directly over pulverizing chamber drops coarse particles back for further pulverizing. Burner vortex turbulent type, adjustable.

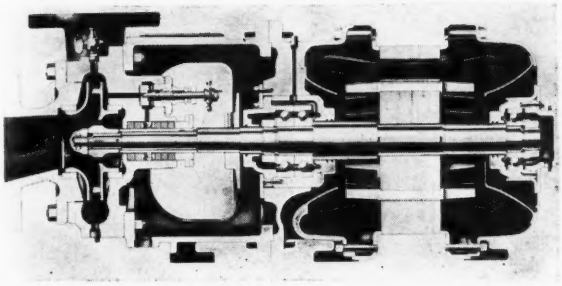
Strong-Scott Mfg. Co., Minneapolis, Minn.

Electrical Supervisory Control

"Polaricode" claimed to be split-second in operation, due to application of "direct selection" principle. Used on 2- or 4-line wires; 2-wire type controlling up to 25 remote apparatus units, 4-wire type controlling up to 2,500 units. Both control number of stations by same wires. In addition, will control remote metering and remote synchronization without additional wires.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.





Combined Motor and Pump

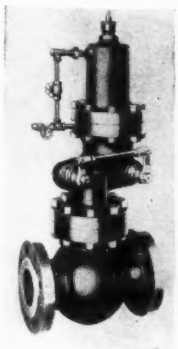
Cameron "Motorpumps" range in size from ¼ to 25 hp. and handle from 5 to 800 g.p.m. of any light liquid. Is complete pumping unit with built-in motor of open, inclosed or explosion-proof type. Heads up to 100 ft. Dust-proof ball bearing construction. One-piece bronze inclosed impeller mounted on motor shaft extension. Stationary renewable wearing rings seal hubs against leakage. Deep stuffing box with water-sealed passage and needle valve control. Renewable bronze sleeve in box. All rotating parts mounted on single shaft. Solid type rotor. Solid motor end shield protects motor. Suction nozzle leads straight to impeller eye; removable for access to impeller.

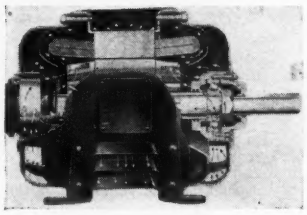
Ingersoll-Rand Co., 11 Broadway, New York City.

Excess Pressure Governor

Type SDS-2 controls within close limits any excess pressure from 15 to 150 lb. Can be used on simplex, duplex or motor- or turbine-driven centrifugal pumps. 4-ply brass sylphon bellows claimed sensitive, yet capable of withstanding 400-lb. pressure. Sylphon and spring-loading in separate chamber from valve to avoid contact with fluid. Spring chromium plated, operates always within elastic limit to extend life. Balanced valve fittings. Rotating valve stem lessens stuffing box friction. All sizes up to 6 in. with straightway or angle style bodies and for all pressure standards from 250 lb. up.

Northern Equipment Co., Erie, Pa.





Splash-Proof Induction Motors

Designed for use where open-motor operation is handicapped by splashing or dripping. End shields of special construction, top half solid to exclude liquids. Ventilating air enters through openings in bottom half, baffle extending to center of motor shaft excluding splashing liquid. One-piece cover fitted on motor frame. Circulating air enters shields, crosses end windings and motor frames, exits through cover.

General Electric Co., Schenectady, N. Y.

Coiled Aluminum Welding Rod

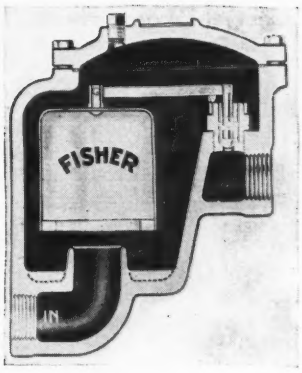
Oxweld No. 14 drawn aluminum rod for welding sheet aluminum and No. 23 rod for welding cast and sheet aluminum and alloys are now available in 10-lb. coils of ⅛-in.

Linde Air Products Co., 30 East 42nd St., New York City.

Low-Capacity Centrifugal Pumps

Designed similarly to maker's double-case, hot-oil pumps, these units have cylindrical outer case with one circular joint, permitting longitudinally split inner case. Units in 3, 5, 7½ and 10 hp., 60-cycle. 3 and 5-hp. units direct-connected, operate at 3,600 r.p.m. to handle from 10 to 30 g.p.m. Inner volute of 3-hp. pump 10 stages; 5-hp., 16 stages. Volute in 8-in. pipe terminating in 2x2-in. square flange for floor mounting. 3-hp., 4 ft. 2 in. high; 5-hp., 5 ft. 3 in. 7½- and 10-hp. pumps designed for gear drive, operating from 1,750-r.p.m. motors to pumps of 5,000 to 5,900 r.p.m. Capacity 10-30 g.p.m. at pressures of 500 lb. (10-hp.) and 375 lb. (7½-hp.).

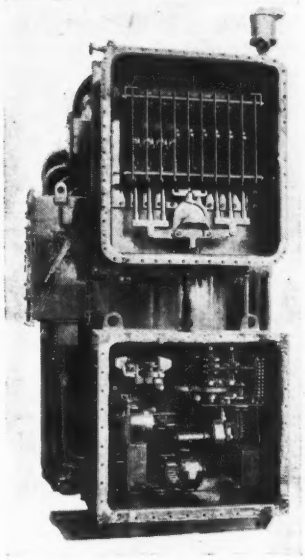
Byron Jackson Co., Foot of Carlton St., Berkeley, Calif.



Inverted Bucket Steam Trap

Class St trap has adjustable valve post, positively guided inner valve, spun brass inverted bucket trap, body and cover of semi-steel, lever and pins stainless steel, as are valve and orifice seat. Pipe connections horizontal with vertical offset. Parts easily removed and exchanged. Bulletin St-10.

Fisher Governor Co., Marshalltown, Iowa.



Tap Changer for Transformers

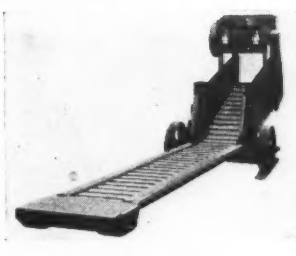
Tap changer practicable for application to transformers as small as 500 kva. per phase and suitable for both single and 3-phase ratings. 3-phase rating forms part of standardized equipment for primary distribution service, including 3-phase transformer with potheads, metal-clad switchgear with relays, etc. Tap changer consists of selector switches for selecting proper tap, transfer switches for transferring load from one tap to another and motor-operated mechanism with equipment for automatic operation. Three transfer switches perform all load switch operations.

Westinghouse Electric & Mfg. Co., Inc., East Pittsburgh, Pa.

Inert Gas Supplier for Transformers

Inertaire protection for transformers is provided by this equipment, consisting of a 200-cu.ft. nitrogen gas cylinder, reducing valve which automatically meters nitrogen to transformer gas space, alarm pressure gage, breathing regulator, and sampling valve. All apparatus housed in sheet steel cabinet interchangeable with chemical type generator used on many Inertaire power transformers.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Portable Troughed Belt Feeder

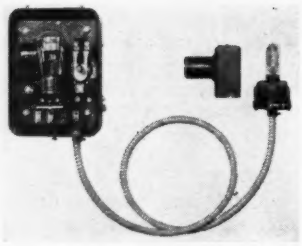
This feeder receives material dropping from hopper of car, and carries it to conveyor or elevator. Feeder 18 in. wide and 14 ft. long, powered by either 3-hp. motor or 4½-hp. gasoline engine. Rubber belt 18 in. wide, fitted with flat cleats on close centers. Belt edges protected. Wear angles on frame at curved section. Carriage wheels mounted on spindles adjustable 8 in. Roller chain drive; pressure lubrication. Unloading capacity, 40 tons coke or 60 coal per hr. Wt., 1,350 lb.

Fairfield Engineering Co., Marion, Ohio.

Proportioneers

In printing item on "Tret-O-Unit" metering pump (*Power*—July, page 51) maker's name appeared as "Proportions." Should be:

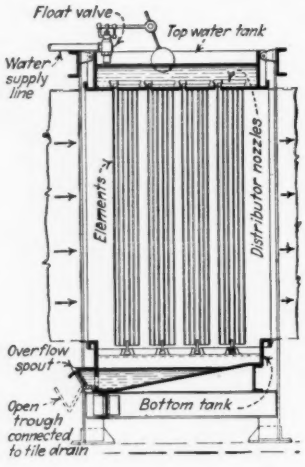
Proportioneers, 77th and Avalon Ave., Chicago, Ill.



General Purpose Photo-Electric Relay

This relay provides more sensitive control and permits operation at minimum light intensity of 3 ft.-cdles, according to maker. Improved construction. Uses Pliotron tube specially designed for industrial purposes.

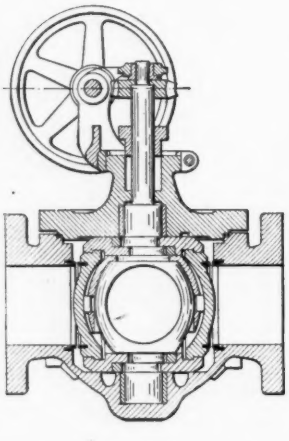
General Electric Co., Schenectady, N. Y.



Flue Gas Scrubber

Riley scrubber consists of series of ribbed baffle plates placed vertically between two tanks. Gases to be cleaned zig-zag through scrubber horizontally, impinging against faces of baffle plates placed at angle to flow. Plate surfaces covered with water which carries dust and soluble gases down and out. Evaporation claimed less than 4 per cent, and size for given steam output or flue gas quantity relatively smaller.

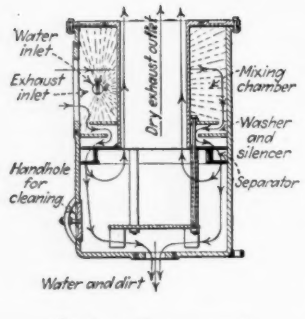
Riley Stoker Corp., Worcester, Mass.



Rotary Valve

A.R.G. rotary valve claimed to eliminate disadvantages of globe and gate valves for larger pipe sizes through enlarging stem in center of body, and providing it with bore equal to internal diameter of valve, thus forming rotary disk holder. Stem is non-rising, permitting lowered over-all height. Adjustable starting bracket permits location of valve control in most convenient position. Two disks are bedded by pilots in rotary disk holder, thus free to move easily. Withdrawal of disks from seats performed by eccentrics on sides of disk holder. Wormwheel drive for valves. Valves either cast iron or steel, seats and disk rings nickel alloy. Extremely rapid operation claimed—20 sec. to close, 50 to open.

Allgemaine Rohrleitung Aktiengesellschaft, Düsseldorf (Germany) Scliessfach 363.



Exhaust Washer and Silencer

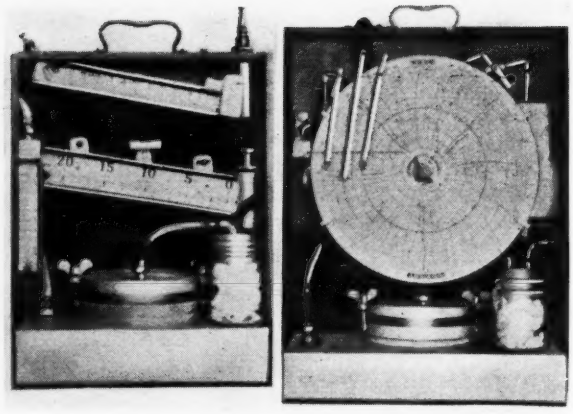
Sizes from 2 to 18 in. are available in Maxim Model EW silencers used on gas, gasoline and diesel engines, 2- or 4-cycle. Claimed to quench all sparks, wash exhaust clean of carbon and dirt, and quiet noise without imposing appreciable back-pressure. Materials entirely cast iron. Inlet on side near top, washing water inlet to one side adjacent to exhaust inlet. Exhaust outlet at center of top. Drain for water and dirt at bottom. Feet cast on for fastening.

Maxim Silencer Co., Hartford, Conn.

Gasket Compound

No. 1281 gasket compound is grey or brown, odorless and sulphur-free alkyd-resin material, called "Glyptal." Flexible and incompressible, unaffected by oil even up to 230 deg. F. Obtainable in sheets to 13x36 in., from one mil to $\frac{1}{8}$ in. thick. Round gaskets available up to $12\frac{1}{2}$ in. in diameter, $\frac{1}{8}$ in. thick; larger sizes later.

General Electric Co., Schenectady, N. Y.



Portable CO_2 Indicators and Recorders

Claimed first and only portable automatic CO_2 indicators and recorders. No moving parts; no running water used; operates on the absorption and Flowmeter principle. Several types. Smallest has indicator reading 0-20 per cent CO_2 in 1-per cent divisions. Case $12\frac{1}{2}$ in. high, $9\frac{3}{4}$ in. wide, $5\frac{3}{4}$ in. deep. Combination CO_2 draft and pressure indicator (left) takes drafts up to 1 in. and wind box air pressure to 8 in. in addition. CO_2 recorders available with from 1 to 3 pens for recording any or all the indicated amounts. 3-pen combination recorder at right.

Defender Automatic Regulator Co., St. Louis, Mo.

Portable Troughed-Belt Conveyor

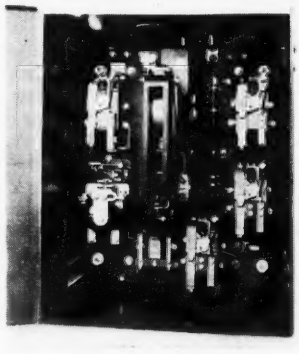
Lengths of 20, 25 and 30 ft.; handles small sizes of coal, claimed sturdy, light, capacious and to require little power. 48-in. carriage wheels mounted on roller bearings. Conveyor belt rubber, 18 in. wide running on roller bearing idlers equipped with pressure grease fittings. Steel plate receiving hopper at foot with rubber wear strips; steel skirt plates form trough 6 in. deep. Return belt protected by plate. Discharge height adjustable. 3-hp. motor or $4\frac{1}{2}$-hp. gasoline engine required for power transmitted to headshaft by roller chain.

Fairfield Engineering Co., Marion, Ohio.

Fusible Alloy for Boiler Control

A fuse in electric circuit controlling burner melts and shuts down burner under excessive temperature. Contains new fusible alloy claimed to remain hard until melting point is nearly reached. Requires 2 min. to melt. Called "Kelly safety boiler control."

Petroleum Heat & Power Co., Stamford, Conn.



Non-Reversing Time Limit Starter

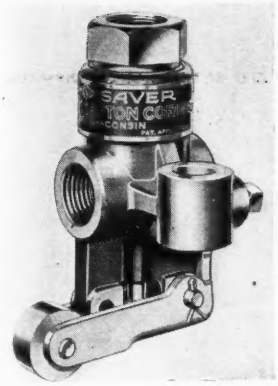
For use with non-reversing constant-speed, d.c. motors on pumps, fans, hoists, etc., "Timetactor" provides definite time limit acceleration without requiring intermediate relays. Controller designed to operate over widest variation in voltage on which d.c. motor will operate satisfactorily. Limiting voltage before starting is that required to pick up and close line contactor, after line contactor picks up is voltage required to volt contact closed. Starter gives instantaneous trip for severe overloads, has time limit acceleration, and operates over widest possible voltage range. Starter also compact. 75-hp., 230-volt unit illustrated is 19 in. wide, 25 high and 22 in. deep.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Steel-Back Bronze Bushings

"Detrolined" bushing stock is seamless steel tubing lined with fused-in bearing metal. Furnished in standard sizes 12 in. in length. Special lengths up to 3 ft. available, as is engineering service. Has less than 50 per cent expansion of bronze, requires only 0.015 in. per surface to finish and withstands force fit, according to maker. Outer diameter can be carburized or welded.

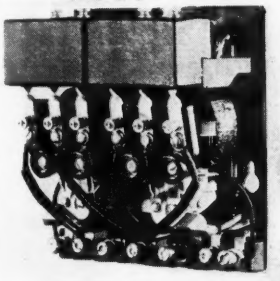
Detroit Seamless Steel Tubes Co., Detroit, Mich.



Air Saver Valve

This device supplies automatic, intermittent control of compressed air blasts for various purposes and operations.

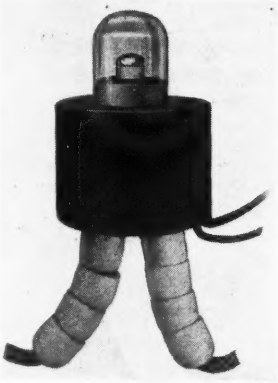
Briggs & Stratton Corp., Milwaukee, Wis.



Reversing Magnetic Contactor

Class 7711 and 8711 3-pole reversing contactors are interchangeable in ratings and dimensions for a.c. and d.c. currents up to 3 hp. Compact design, small dimensions, convenient wiring, positive mechanical interlock of contactors and magnetic safety latches preventing accidental closing, claimed by maker. Arranged for either 2- or 3-wire control. Edgewise mounting of movable contacts and form of arc suppressors claimed to increase arc-rupturing capacity. Class 8711 for a.c.; Class 7711 for d.c.

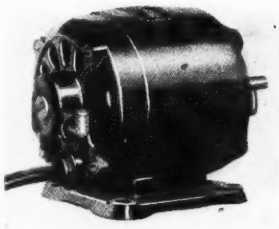
Industrial Controller Division, Square D Co., Milwaukee, Wis.



Mercury Switches

"Magnetrole" mercury switches range in capacity from 1-100 amp. In types with ratings up to 5 amp., special heat-resisting contacts used. In larger switches, arcing occurs over ceramic surface to eliminate tube breakage.

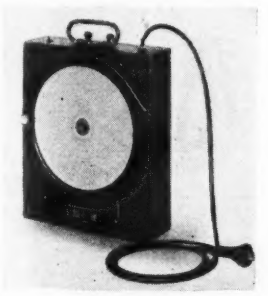
Providence Electric Controls, Inc., 763 Allens Ave., Providence, R. I.



Small Motors

Rated at 1/20 and 1/15 hp. at 1,725 and 3,400 r.p.m., Type N-3 motors with wool-packed bearings available as synchronous, split-phase induction and series or shunt d.c. types in same frame. Simplified automatic cutout incorporated.

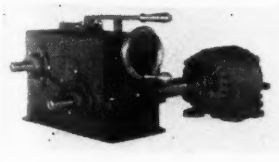
Bodine Electric Co., 2264 W. Ohio St., Chicago, Ill.



Recording Pyrometer

Type SR portable, electrically driven recording pyrometers weigh 17 lb. Circular chart, 8½ in. in diameter, driven by self-starting synchronous electric clock movement, provides 24-hr. temperature record.

Hoskins Mfg. Co., Detroit, Mich.



Variable-Speed Transmission and Reduction Unit

Speeds from 15 to 150 r.p.m. with 1,750-r.p.m. motor obtainable from this variable-speed transmission and reduction unit. Forward, neutral and reverse accomplished by shift lever with motor in motion. Speed, controlled by handwheel, changeable while unit is operating.

Lenney Machine & Mfg. Co., Warren, Ohio.

Capacitor Motors

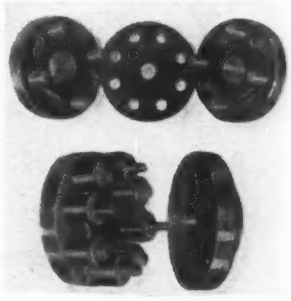
Type RZH condenser-start, condenser-run, split-phase motors vary condenser capacity from start to run by means of a switch and auto-transformer. Motors are available as rigid or rubber-mounted types in conventional sizes.

Wagner Electric Corp., 6396 Plymouth Ave., St. Louis, Mo.

Flexible Coupling

Shock resistance and method of eliminating vibration claimed incorporated as is also compensation for parallel and angular misalignment. Will operate at speeds up to 3,450 r.p.m. Sizes manufactured for transmitting up to 1,200 hp.

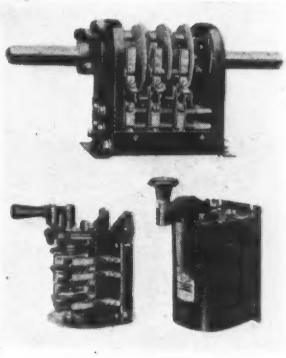
F.A.B. Mfg. Co., 67th and Vallejo Sts., Oakland, Calif.



Drum Controllers

A.c. and d.c. across-the-line reversing drum controllers available in two- or three-pole types, with radial or rope lever-operating mechanism, self-centering or non-centering mechanism, and with or without either main-line, limit-switch protection or pilot-circuit interlocks.

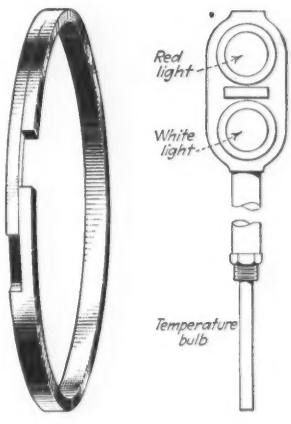
Cutler-Hammer, Inc., 205 N. 12th St., Milwaukee, Wis.



Piston Ring

Claimed to seal gap against cylinder wall and ring groove and prevent blow-by, this one-piece "Double-Seal" ring retains design features of two-piece rings of maker. Claimed to improve compression of worn diesel cylinders 10 per cent.

Double Seal Ring Co., Fort Worth, Tex.



Electric Temperature Signal

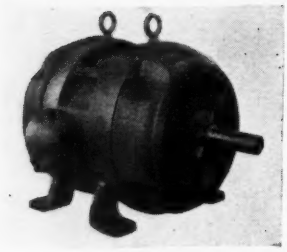
"Thermo-tel" consists of differently colored electric lights actuated by temperature changes, showing low, high or right temperature for any desired setting within one-tenth deg. Can be placed remote from temperature observed; can be read at 200 ft., according to maker.

Uehling Instrument Co., Paterson, N. J.

Self-Opening Diehead

"Red - E - Quick" automatic quick-opening and self-setting dieheads require but two sets of dies to thread all sizes of pipe from ½ to 2 in. Means are provided for adjustment.

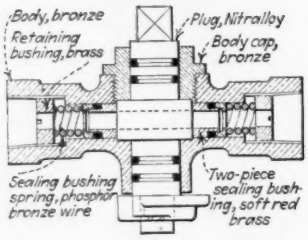
American Die & Tool Co., Reading, Pa.



A. C. Reversing Motors

Cartridge-type ball bearings furnished in these inclosed, fan-cooled motors, designed with torque characteristics to reverse 40 times per min.

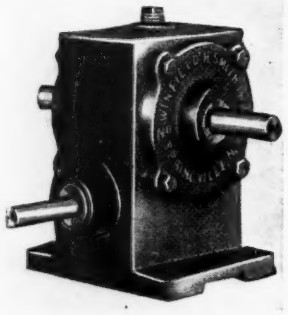
Reliance Electric & Engineering Co., 1042-1090 Ivanhoe Rd., Cleveland, Ohio.



Improved Hydraulic Valves

Yarway hydraulic valves now use 2-piece sealing bushings and cost Nitralloy plugs. (Cast alloy replaces aluminum with vanadium; claimed to avoid blisters on wearing surfaces). Plug presents hard surface backed by tough core which resists sealing bushing action. Sealing bushing wears itself in against plug; claimed to give much longer life, coupled with positive sealing. Bushing leathers now slipped over one part of bushing, retaining ring being forced against packing ring by spring action. New method of packing plug (not shown) uses expanding cup leathers instead of ring packing illustrated.

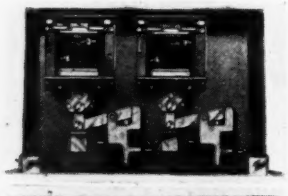
Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

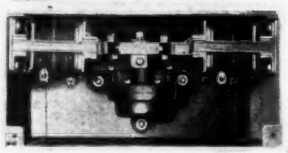


Worm Gear Speed Reducers

No. 3½B permits loads up to ¼ hp. and has solid-top housing with large side cover plates. This permits keying worm gear to shaft. Standard ratios: 58:1, 36:1, 18:1, 9:1. No. 4½T designed for medium-duty service, has standard ratios from ⅛ to 1/60, with hp. output from 1.5-0.25.

Winfield H. Smith, Inc., Springville, Erie County, N. Y.

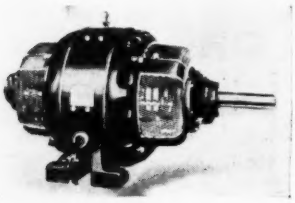




Electrically-Operated Air Valves

Model C (top) furnished in both double and single types for remote control of either double- or single-acting air cylinders. Can be operated from one or more pushbutton stations. Model D designed for time-cycle operation or remote control of an air cylinder. Model E for 4-way control of double-acting air cylinders.

Hannifin Mfg. Co., 621 S. Kolmar Ave., Chicago, Ill.



Synchronous Motor

"Ideal Self-Syn," especially developed for industrial and general purpose use, claimed compact, self-excited, self-synchronizing, self-contained motor units requiring no external excitation. Started with hand-operated compensator. Can resynchronize itself if pulled out of step by voltage drop, etc. Unity or 80 per cent leading power factor standard. All sizes from 5 to 100 hp. at 9,000, 1,200 and 1,800 r.p.m.

Ideal Electric & Mfg. Co., Mansfield, Ohio.

Soldering Lugs

Soldering lugs for standard or heavy duty are claimed of special construction providing two bolts each, and adequate for general purposes. Will not permit cable to fuse in case of sustained short circuits. Furnished only in long-tongue, two-hole style. Heavy-duty lugs interchangeable with standard cast lugs.

H. B. Sherman Mfg. Co., Battle Creek, Mich.

Transmission

"Multi-Speed" transmissions claimed to prevent slippage because idler disk sets up wedging action in direct proportion to transmitted load. Speed changes made by star knob or top. Grooved cones of steel, composition disk running as idler between. Ratios in 8 speed changes up to 9:1 and in sizes from ¼ to 10 hp.

General Radial Drill Co., 1767 Elmore St., Cincinnati.

Liquid Level Recorder

Type H "Rational" liquid level recorder of float type, pencil recording on weekly chart on cylinder. Float operates cylinder through gearing, pencil by weight regulated by clock. Float travel reduction scales from 1-1 to 1-100. Rate of pencil travel and ratio changeable at will. Size 8x14½x10¾ in.

Rational Mfg. Co., Redondo Beach, Calif.

Stainless Steel Motor

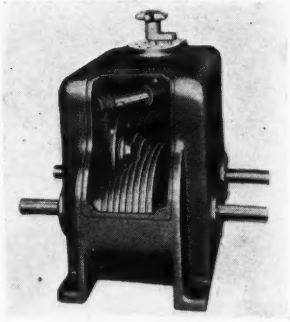
Dustproof design similar to other similar Lincoln motors, plus inclosure and corrugated heat-radiating surface of stainless steel, make this motor resistant to corrosion, dust and dirt, according to maker.

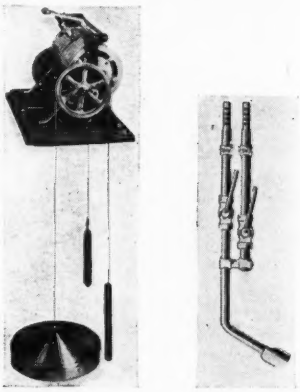
Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.

Damper and Furnace Draft Regulators

Junior model small furnace draft regulators (left) control boiler dampers; stoker and fan motor speeds are controlled by automatic pressure regulators (right) functioning from boiler steam pressure. Operate on gas-, oil- or coal-fired boilers. Draft regulator used on stoker-fired boilers whose stokers have automatic pressure switches. Pressure regulator may also operate chronometer valves on steam-turbine operated stokers or boiler damper for constant furnace draft. Regulators work on 1-oz. pressure change and will make 16 stops for 1-lb. pressure change or any variation from 1 to 10 lb., or can be set for any smaller number of stops within same limits. Small draft regulators assembled on one-piece cast aluminum housing, 12½x12½x6 in.

Defender Automatic Regulator Co., St. Louis, Mo.





Natural Gas Blowpipes

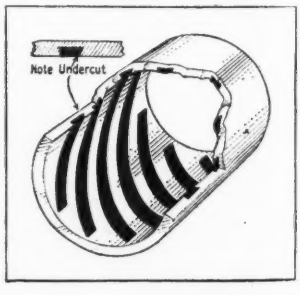
Compressed air and natural gas fire these blowpipes, supplied for soldering, light brazing, tempering, melting, rebabbitting, wire splicing, core drying, etc., but not for welding.

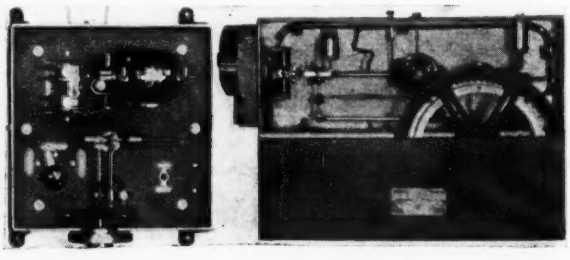
Torit Mfg. Co., 174 West 3rd St., St. Paul, Minn.

Oilless Bearing

Designed for sliding or oscillating motion with axis either vertical or horizontal, this spiral type oilless bearing will operate at speeds up to 2,500 r.p.m., depending upon load, and at temperature not above 400 deg. F.

E. A. Williams & Son, Inc., 111 Plymouth St., Jersey City, N. J.





Inverted Bucket Steam Traps

No. 70 (shown) and 71 Strong inverted-bucket steam traps use same anti-balancing principle as Series 20, described June 21. Valve arrangement replaces conventional air vent hole in bucket. Small vent open when valve is filling. As bucket loses weight, valve is opened wide to permit sudden escape of steam and air and avoid balancing. Steam and air replaced with water which sinks bucket and opens trap discharge valve. Bucket suspended on tapered spindle, and clearance between spindle and hole in plate on bucket serves as air vent. Makers claim can be used on exhaust steam containing oil and sediment. Disks and seats Anum-Metl, lever, pins and wear plate work-hardening steel. No. 70 for pressures of 0-125 lb. and No. 71 for 0-200 lb.; both semi-steel bodied. No. 71 also available with cast steel body for installations where superheat is present at intervals.

Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Control and Instrument Switches

SB-L is available in various combinations for operating circuit breakers, governors, rheostats, instrument transfers, etc. Made up of interchangeable parts, it is claimed compact and inexpensive. Combinations differ only in number of contacts and arrangement of switch-operating cams. Escutcheon plate markings and handle styles differ for various services. Breaker control switch available with auxiliary contacts for dim-bright indicating lamp scheme.

General Electric Co., Schenectady, N. Y.

Gear Motors

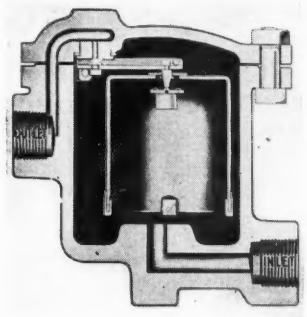
Normal-speed motor combined with built-in, internal-helical, planetary-gear speed reducer. Permits wide choice of output speeds. Maker claims compact construction, high efficiency, full horsepower rating at output shaft, economy of operation, simple design. Available with either flanged or vertical mountings; also with special electrical characteristics (high starting torque with low starting current, etc.) or mechanical features (totally inclosed, etc.). A.C. polyphase, squirrel-cage and wound-rotor motors available in ratings up to 75 hp., single phase to 5 hp., d.c. to 7½ hp. Speeds down to 13 r.p.m. Illustration shows details of gear unit.

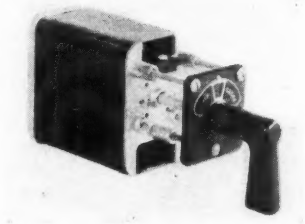
General Electric Co., Schenectady, N. Y.

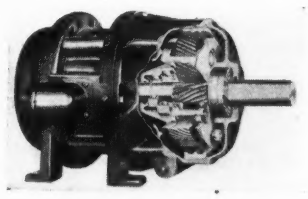
Gas-Engine Driven Welders

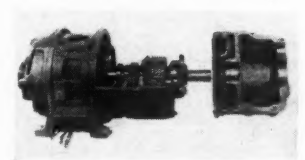
300- and 400-amp. gas-engine-driven FlexArc welders claimed to have full canopy weather protection, accessible controls, dependable power and transformer-type reactance to prevent current surges and electrode sticking. Standard units have 6-in. rim steel-tired wheels. Smaller shop wheels if desired, or pneumatic and solid rubber types. Overside exciters are available.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa









Gearmotors

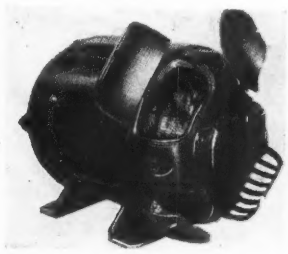
Type CS general all-purpose induction motor and double-reduction, non-planetary helical-gear speed reducer built into one-piece motor frame. Gearmotors built in sizes from ½ to 15 hp., with outputs ranging from 69 to 1,500 r.p.m.

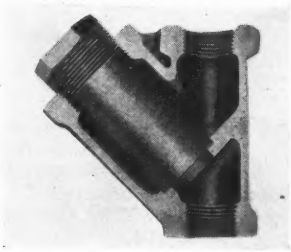
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

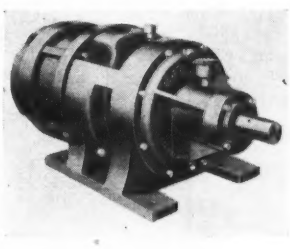
Repulsion-Induction Motors

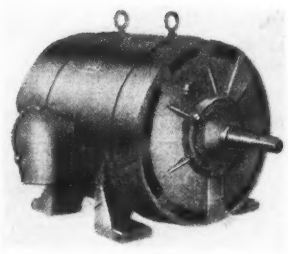
Type RG repulsion-induction motors claimed to have smooth speed-torque curve throughout operating range and to possess these characteristics: low starting current, close speed regulation, positive operation on low voltage, high power factor, good commutation and no internal short-circuiting or brush-lifting mechanism. Bolt holes permit 90-, 180-deg. rotation of end plates.

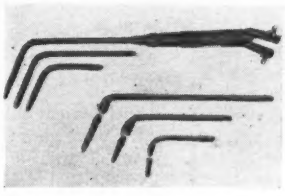
Wagner Electric Co., 6396 Plymouth Ave., St. Louis, Mo.



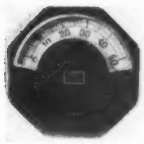








Liquid Flow Meter



"Isometer" consists of actuator located in pipeline, which movements are transmitted to meter body. Meter body in three styles; plain indicating; indicating; and integrating, indicating integrating and chart recording. Line or remote types. Scales graduated in either U. S. gal. per min. or lb. per hr. Actuator units for 125, 250, 400 or 600 lb.

Isometer Co., 2357 North 29th St., Milwaukee, Wis.

Pipe-Line Strainer

This self-cleaning strainer for installation on return line of systems up to 125 lb. per sq.in. pressure will remove dirt, grit and scale and can be installed either horizontally or vertically. It is self-straining and draining when plug is out or blow-off valve open. Made in six sizes: ¼, ⅜, 1, 1¼, 1½, and 2-in. pipe.

Jas. P. Marsh & Co., Chicago, Ill.

Roller Bearings

These bearings have two lips on inner ring or cone and one lip on outer ring or cup, with detachable spring-steel locking lip on other side. This allows bearing to take limited amount of thrust load in one direction.

Bantam Ball Bearing Co., South Bend, Ind.

Motorized Speed Reducers

Motorized planetary-type speed reducers designed for limited-space applications. Housing for reduction gears integral with base. 34 standard ratios available, 4:1 to 240:1. Sizes range from ¼ to 30 hp.

Gears & Forgings, Inc., Cleveland, Ohio.

Induction Motors

Ranging in size from ¾ to 200 hp., this line of induction motors was originally designed for punch-press service. Frame fabricated from bar steel, electrically welded. Open, fully inclosed, or fan-cooled types.

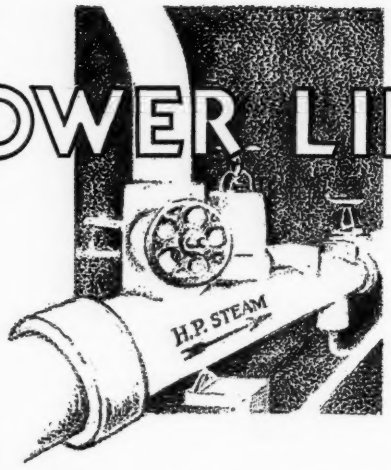
Reliance Electric & Engineering Co., 1042-1090 Ivanhoe Rd., Cleveland, Ohio.

Welding Torch

Type HMS is for all types of welding. Copper swaged tips furnished may be replaced by extensions of various lengths.

Alexander Milburn Co., 1416-1428 W. Baltimore St., Baltimore, Md.

POWER LINES



Public Utility Power Production Increases 2 per Cent in June

Electric power production of public utility power plants in the United States during the first six months of this year totaled 41,793,000,000 kw.-hr., as compared with 45,843,000,000 kw.-hr. produced in the corresponding period of 1931, according to figures just released by the Geological Survey of the Department of the Interior. This amounts to a decrease of 9 per cent from last year's production and a drop of 6 per cent under the production level of the same period in 1930.

As shown by the chart, average daily production of electricity by public-utility plants in June, 1932, was 217,900,000 kw.-hr., about 2 per cent more than the daily production for May. The normal increase in daily output from May to June is about 1.5 per cent, it is stated by the Geological Survey.

Average daily production of electricity by the use of water power in June of this year was 7 per cent less than in April. During the first half of 1932 hydro-electric power amounted to 43 per cent of the total output, as compared with 36 per cent for 1931.

Power production figures of the Geological Survey are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, both commercial and municipal, electric railway plants, plants operated by steam railroads generating electricity for traction, Bureau of Reclamation plants, public works plants and that part of the output of manufacturing plants which is sold for public use.

Canadian Research Laboratories Dedicated

In the presence of distinguished visitors from Great Britain and the British Dominions who are attending the Imperial Economic Conference, the new National Research Laboratories building at Ottawa, Canada, was formally opened by the Governor General of Canada, on the evening of Wednesday, Aug. 10. R. B. Bennett, Prime Minister of Canada; H. H. Stevens, chairman of the Committee of the Privy Council on Scientific and Industrial Research, and Dr. H. M. Cory, president of the National Research Council, participated in the ceremonies. Those in attendance included other members of the Government of Canada, members and ex-members of the National Research Council, official representatives of scientific societies, and representatives of Canadian universities.

Constructed at a cost in excess of $3,000,000, the new laboratories represent the nation's most ambitious scientific undertaking. The building, containing approximately 250,000 sq.ft. of floor space, is 418 ft. long, 176 ft. wide and 60 ft. high. It is of steel-frame construction faced with Wallace sandstone brought from quarries in Nova Scotia. As the structure has been erected for purposes of research it is, generally speaking, a system of laboratory units, with accommodation on the main floor for the Council staff.

Almost the entire rear portion of both the basement and first floor will be occupied by the engineering physics laboratories. Here the testing machines and cranes that require a high ceiling will be located. The crane in the hydraulic and thermo-dynamic laboratories will be of 15 tons' capacity. In the electrical laboratories will be apparatus capable of testing up to 600,000 volts or more.

Throughout the other portions of the building are what are called unit laboratories, 12 ft. by 20 ft., separated by temporary partitions that may be removed without breaking into the walls of the building, to accommodate the various types of work that the future will bring. In the northwest end of the building are the electrical laboratories and other branches of the Division of Physics and Engineering. A complete description of the new laboratories and the annex was given in the June 7, 1932, number of *Power*.

COMING MEETINGS

10th National Power Show—Grand Central Palace, New York City, Dec. 5-10, during annual meeting, A.S.M.E. Conducted by International Exposition Co., Grand Central Palace, New York City. Charles F. Roth and Fred W. Payne, managers.

Universal Craftsmen Council of Engineers. Annual convention at Cedar Point, Ohio, Aug. 8-13. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Safety Congress and Exhibition—21st Annual, Washington, D. C., Oct. 3-7. Headquarters of the National Safety Council, Sponsor, 20 N. Wacker Drive, Chicago, Ill.

American Institute of Electrical Engineers—Pacific Coast Convention, Vancouver, B. C., Aug. 29-Sept. 2. Middle Eastern District meeting, Oct. 10-13, Baltimore, Md. National Headquarters, 33 West 39th St., New York City.

Institution of Mechanical Engineers (Great Britain)—Summer meeting in Canada, Aug. 28-Sept. 9. Includes visits to Rochester, Schenectady and New York, including Hell Gate & Hudson Ave. power stations. Magnus Mowat, secretary, Storey's Gate, St. James Park, London, S.W.1, England.

Pennsylvania Electric Association—Annual Convention, at Bedford Springs Hotel, Bedford Springs, Pa., Sept. 7, 8 and 9.

American Society of Civil Engineers—Fall Meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., Oct. 5-8.

American Welding Society—12th Fall Meeting, Statler Hotel, Buffalo, N. Y., Oct. 3-7. Wm. Spraragan, secretary, 29 West 39th St., New York City.

Big Utility Contract Awarded to Westinghouse

As part of an electrical project calling for the expenditure of 8½ million dollars in the next two years, a contract of approximately 1¾ million dollars has been awarded to Westinghouse Electric & Mfg. Co. by Philadelphia Electric Co. for a 183,000-kva. turbine generator to be installed at the Richmond Generating plant, on the Delaware River, Philadelphia, Pa. (*Power*—July, page 55). The Westinghouse contract is among the largest awarded for generating equipment in several years.

The single-shaft generating set will consist of a 1,800-r.p.m. turbine, as powerful as any yet built, and a 165,000-kw., 3-phase, 60-cycle, 13.8-kv. double-winding generator. About two years will be required to complete the installation; the new equipment is to be ready for commercial service by Nov. 1, 1934.

"Power" Index Ready

The index covering numbers of *Power* issued during the first half of 1932 has been separately printed and is now available for distribution. Single copies will be forwarded to subscribers on request.

Economic Conference for Engineers

The second annual Economic Conference for Engineers will be held at the Stevens Engineering Camp on the general thesis of "Money and Banking" from Aug. 27 through Sept. 5. While last year, Columbia University and Stevens Institute sponsored the camp, this year's announcement has been made on behalf of alumni and engineering associations of Brown University, Columbia, Cornell, Harvard, Massachusetts Institute of Technology, Princeton, Rensselaer Polytechnic Institute, Stevens Institute of Technology, Yale, and the American Association for Adult Education.

Electrical Congress Includes 300 Papers

More than 300 reports and papers on electrical and related subjects were presented before the thirteen sections of the International Electrical Congress in Paris July 5-12, according to the report of Dr. A. E. Kennelly, chairman of the American delegation, to Dr. Clayton H. Sharpe, president of the U. S. National Committee of the International Electrotechnical Commission. Outstanding papers presented at the Congress by American authors were: "The Search for Better Ferro-Magnetic Materials," by T. D. Yensen; "Development of Electrical Machinery in the U. S.," by P. L. Alger and F. D. Newbury; "Production and Transformation of Electrical Energy in the U. S.," by F. A. Allner, A. D. Bailley, A. G. Christie and F. C. Hanker; "Evolution and Development of Railway Electrification in the U. S.," by E. L. Moreland, and "World-Wide Telephony, Its Problems and Future," by F. B. Jewett and B. Gherardi.

N. Y. Engineer Laws Amended This Year

New York State Architects and Engineers Laws have been amended (Articles 5 and 56 of the Education Law) so that licensed professional engineers may practice architecture and registered architects may practice engineering, though the members of one group are not permitted to use the designations of the other. By the new law, both architects and engineers are permitted to have and use seals.

Power Commission Issues Holding Co. Report

Federal Power Commission has in press its report on "Holding Company Control" of its licensees. The report will be about 150 pages in length and largely statistical in character. Tables will present much of the information gained from the replies of companies to the questionnaire sent out last summer. More than a score of charts illustrating the corporate structure of the groups, formed by the "top" companies and their subsidiaries, will be included.

Plan Huge Power Dam At St. Louis, Mo.

Carl G. Stifel of St. Louis, Mo., has filed an application with the Federal Power Commission for permission to construct a power dam on the Mississippi River near the Chain of Rocks bridge. The Federal Power Commission has in turn given notice of the application to the St. Louis and St. Charles county officials of Missouri, and they, and the City of St. Louis, as well as firms and private individuals will have until Sept. 15 to file objections to the application.

The application calls for a power project which will develop 175,000 hp. to serve industries located near the site of the dam. The project also includes the construction of a lock system near the Missouri shore of the river and an earth embankment to connect with the existing system of levees on the Illinois shore, where the power house is to be located.

It is estimated that the proposed dam will raise the low water stage of the river above the dam to 25 ft., backing water as far upstream as Grafton, Ill., near the mouth of the Illinois River, a distance of 15-20 miles.

Steel Boiler Orders Show June Increase

Orders for steel boilers in June of this year showed an increase from 265 to 328 over May, increasing also from 258,245 to 321,959 sq.ft. Orders for stationary boilers increased from 258 to 323, the number of square feet increasing from 248,813 to 316,662. Water-tube units sold increased from 33 to 42, square footage increasing from 116,381 to 157,732.

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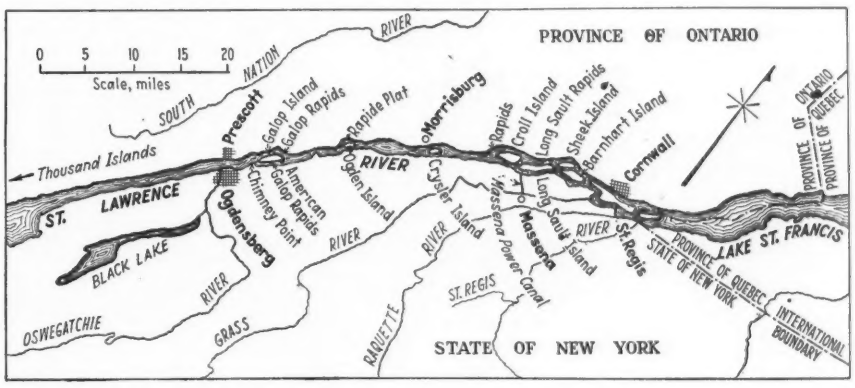
Treaty Signed for St. Lawrence Development

ON JULY 18 a treaty was signed in Washington, D. C., by diplomatic representatives of the Canadian and United States Governments for the development of a deep waterway from the Great Lakes out the St. Lawrence River. This agreement was reached after eleven years of effort and agitation by interests in the two countries. The completed project, which contemplates a 27-ft. waterway from Duluth, Minn., to the Atlantic by way of the St. Lawrence River, will cost between $800,000,000 and $900,000,000, which is about three times the cost of the Panama Canal. It is estimated that ten years will be required to complete the work, and that the cost will be divided about equally between Canada and the United States, credit being allowed each country for cost of work already done.

In addition to the waterway, about 5,000,000 hp. of waterpower will be developed along the St. Lawrence River. Of this over 2,000,000 hp. will be generated in the international section of the river between the Province of Ontario and New York State. One-half of this power will go to each of the two interests. According to the terms of the treaty, power in the international section will be developed at two sites instead of one, as originally proposed by the United States. This is a concession to Canadian interests who have favored the two-dam development. The international rapids section of the river embraces 48 mi. of swift water between Chimney Point and Lake St. Francis. Here the river runs in a succession of rapids beginning with Galop Rapids and ending with Long Sault Rapids, with a total of 92 ft. fall. One dam, to provide a head of about 25 ft., will cross the river at Crysler Island with a navigation canal and locks on the Canadian side. At this dam will be two power houses, one on either side of the international boundary, in which a total of 530,000 hp. will be installed. The second dam will cross the river near Cornwall, where an average head of about 60 ft. is available, and two power houses will be constructed with an aggregate capacity of 1,600,000 hp.

Several questions remain to be settled before the work can be started as a joint undertaking by the two countries. The treaty must first be approved by the governments of the two countries. It is possible that this may take a long time, as certain provincial and state interests in the two governments are by no means favorable to the project. This and other obstacles may delay the final joint agreement for years.

It should not be lost sight of, however, that already a great deal of work has been completed on what will be the final project. At the present time the United States government is deepening the channel to 27 ft. between Lakes Superior and Huron. Canada, at a cost of $120,000,000, has reconstructed the Welland Canal for 27-ft. draft. Between Lakes St. Francis and St. Louis on the St. Lawrence River in Quebec, the Beauharnois Power Corporation has under construction a power project that will ultimately have 2,000,000-hp. capacity. The canal for this project, which is 15 mi. long, is designed for navigation and is being dredged to 27-ft. channel. Consequently, no matter what may be the outcome of the present negotiations between the United States and Canada for joint development of a seaway, when the construction now under way is completed about one-half of the total work that is necessary to provide a 27-ft. channel from Duluth, Minn., to Montreal, Canada, will have been done.



OBITUARIES

WILLIAM J. RANTON, one of the organizers of the Universal Craftsman Council of Engineers (founded 1903) and at the time of his death supervising engineer in charge of inspection work for the Fidelity & Casualty Insurance Co., died at his home in Rochester, N. Y., July 17. He had been with Fidelity & Casualty Insurance Co. for the past 30 years, and also took a prominent part in the educational work of the National Association of Power Engineers. He had been an officer in several associations.

WALTER B. CLINE, 69, chairman of the board of Los Angeles Gas & Electric Corp., and for the past 43 years a leader in the public utility field in southern California, died at his home July 21.

HENRY H. KERR, 68, vice-president of United Engineers & Constructors, Philadelphia and New York, died July 21.

WILLIAM W. TEFFT, vice-president of the Fargo Engineering Co., Jackson, Mich., died June 24. Mr. Tefft was well known in the hydro-electric engineering field. In 1919 he became associated with Hodenpyl, Hardy & Company and later became chief engineer and vice-president of Commonwealth Power Corp. and Consumers Power Co. In 1928 he entered private practice as a consulting engineer and in 1929 became vice-president of the Fargo Engineering Company.

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PERSONALS

HENRY C. MILLER has been appointed sales manager of the Power Plant Equipment Division of Swartwout Co., Cleveland. During Mr. Miller's twelve years experience with the company, he has served in responsible positions in connection with the design, manufacturing, selling, and servicing of Swartwout equipment.

WALTER A. BLACK, formerly chief engineer of the Indianapolis works of Fairbanks-Morse & Co., has been appointed by Allen-Bradley Co., as district manager of the office at 942 Prospect Ave., Cleveland, Ohio. JOHN B. VOGEL was recently appointed by Allen-Bradley as district representative in charge of the office at 41 Grandville Ave., S.W., Grand Rapids, Mich. Mr. Vogel has 15 years' experience in the industrial field.

ARTHUR NEWELL TALBOT, professor emeritus of Municipal and Sanitary Engineering at the University of Illinois and an international authority of his profession, was recently awarded the Lamme Medal at the fortieth annual meeting of the Society for the Promotion of Engineering Education at the Oregon State College, Corvallis, Ore. The award is bestowed annually in accordance with the provisions of the will of the late Benjamin G. Lamme, who was chief engineer of the Westinghouse Electric & Mfg. Co.

NORMAN W. FOY has ben appointed Chicago district sales manager of Republic Steel Corp., according to an announcement made by N. J. CLARKE, vice-pres. in charge of sales. Mr. Foy became associated with the old Republic Iron & Steel Co. in 1919. He was subsequently manager of the company's Buffalo, Boston and Birmingham offices, being made ass't western manager of sales shortly after the formation of the present Republic Corporation.

R. F. BALDWIN, who has represented Irving Iron works, Long Island City, N. Y., in the Philadelphia territory for the past ten years, has been appointed Philadelphia district sales representative by Hendrick Mfg. Co., Carbondale, Pa. His headquarters will be at 5813 North Fairhill St., Philadelphia.

ARTHUR P. MILLER, formerly with the A. P. Miller Supply Co. Inc., announces the organization of A. & H. Miller, Inc. at 370 Lexington Ave., New York City. The new company will do business as manufacturers' representative and distributor of ice and refrigerating equipment, supplies, chemicals, specialties, etc.

H. M. OLSON, formerly district sales manager of the Permutit Co., Pittsburgh, Pa., and also formerly with the Kennicott Co., Chicago, is to assume his duties as special representative for the Ohio Salt Co., Wadsworth, Ohio, to promote the sale of salt for water softening purposes. His home office will be 171 Longue Vue Drive, Pittsburgh, Pa.

Worthington Consolidates Cincinnati-Buffalo Plants

Worthington Pump & Machinery Corp., 2 Park Ave., New York City, has announced a decision to transfer and consolidate the designing, engineering and manufacturing activities formerly carried on at the Cincinnati (Ohio) works with those of the Buffalo (N. Y.) manufacturing plant. For the present, Cincinnati plant equipment will remain intact. This move in no way affects Worthington's Cincinnati district sales office.

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BUSINESS NOTES

FOSTER WHEELER CORP., 165 Broadway, New York City, has appointed Consolidated Steel Corp., Ltd., exclusive sales and manufacturing representatives for Foster Wheeler products on the Pacific Coast, including the states of California, Washington, Oregon, Nevada, Utah, Arizona and New Mexico. Foster Wheeler will continue to maintain an engineering organization in Los Angeles under direction of W. L. Rifenberick, chief engineer of the Gasoline Department in Calif. This Engineering Department will remain in its former offices in the Petroleum Securities Building.

MASON REGULATOR CO., Boston, Mass., announce the appointment of the O'Brien Steam Specialty Co., Syracuse, N. Y., as exclusive representative for western and northern New York state. O'Brien Steam Specialty Co. has offices in Syracuse, Rochester and Niagara Falls.

SARCO CO., INC., 183 Madison Ave., New York City, has been appointed exclusive distributor in Greater New York of the entire line of valves for radiators and industrial purposes manufactured by Marsh Valve Co., Dunkirk, N. Y.

NORDBERG MFG. CO., Milwaukee, Wis., has moved its New York Office from 51 East 42d St. to the Lincoln Bldg., at 60 East 42d St., and its Los Angeles office from 1462 Stanley Ave. to the Subway Terminal Bldg., 417 South Hill St.

J. D. GERKEN CO. has been appointed distributor in the Toledo territory for Auburn hydraulic stokers and Taylor steam traps, pumps and receivers.

POOLE FOUNDRY & MACHINE CO., Baltimore, Md., has appointed Ladd Equipment Co., First National Bank Bldg., Pittsburgh, as district representative in western Pennsylvania, West Virginia and eastern Ohio.

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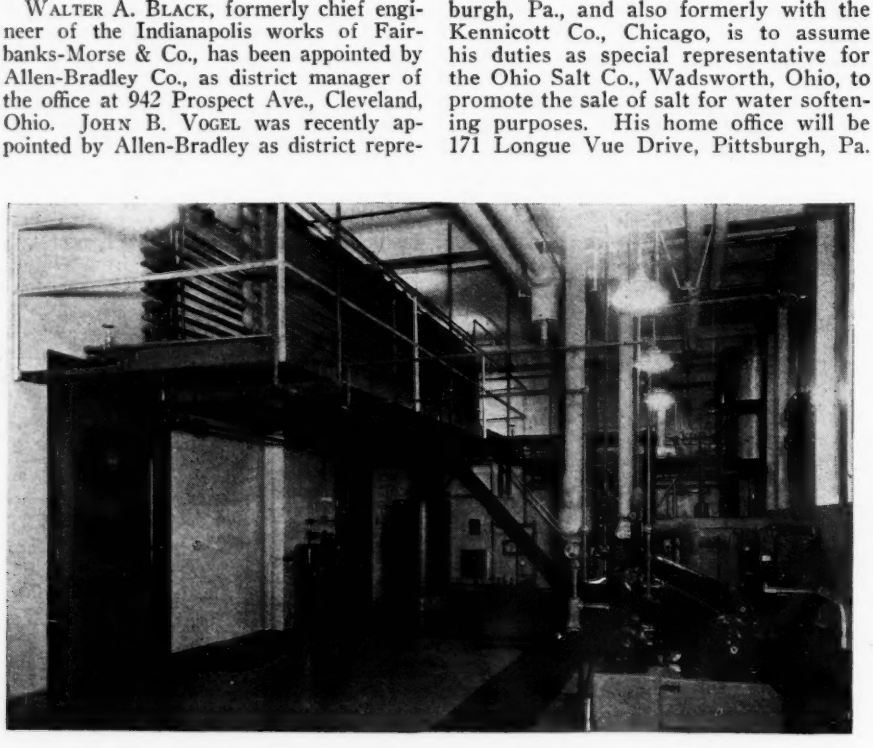

One 4- and one 1½-ton ammonia compressor systems and a carbon-dioxide compressor of about 1½-ton capacity are part of the equipment of the new refrigeration laboratory of Lehigh University. Equipment and auxiliaries are arranged so that the ammonia and CO_2 units may be run in together for low-temperature work. Instruments have been provided for making all measurements that may be required for research work

Photo by Fairchild Aerial Surveys, Inc.

Six contracts have been let for boilers, steam piping and tunnels to furnish heat for more than 20 Government buildings in this group in Washington. Contracts for the power plant itself have not yet been placed. Latest contract, for $1,250,000, was awarded Northeastern Piping & Construction Corp. for 42,800 ft. of steam piping.

STRAWS

Pointing the way the business wind blows

Industrial consumption of electric power increasing, particularly in process and food industries.

About $900,000 worth of motors, pumping machinery and loading equipment will be installed in the bulk oil storage and distributing plant of Standard Oil Co. at Quincy, Mass.

Latest Government contracts include: $2,872,000 postoffice at Newark, N. J.; $1,000,000 Federal Reserve Bank at Philadelphia; $2,000,000 postoffice at Minneapolis, Minn.; $1,500,000 appraisers' stores building in Chicago; $7,500,000 postoffice building in Philadelphia; $7,667,000 Department of Justice building at Washington; $1,000,000 officers' quarters in Canal Zone (bids Aug. 15). All these involve power or heating plants, elevator equipment, and other business for the power field.

Potomac Electric Co. has let a contract involving $4,000,000 to Stone & Webster for construction of a steam power station at Buzzard's Point, Md. The 35,000-kw. plant is to be completed by Oct. 1, 1933.

Capiland Timber Co., Ltd., Vancouver, B. C., will construct a $250,000 power plant, shingle mill, lath mill and saw mill.

Construction of a municipal system with complete equipment including power house and distribution facilities is asked for in bids closing July 20 by Board of City Commissioners, Piqua, Ohio. Appropriation of $700,000 made.

Grand Falls hydro-electric plant of St. John River Power Co. has made a new hig.. single-day output record, producing 1,368,000 kw.-hr. of electrical energy.

New locomotive-type boilers with necessary auxiliaries will soon replace the three existing boilers at the Field, B. C., powerhouse. This will require enlargement of the powerhouse and reconstruction of the stack.

Contract for erection of a 700-hp. turbogenerator plant at Sheep Creek for Reno Gold Mines, Ltd., near Nelson, B. C., has been awarded.

Bids received July 15 for construction of a powerhouse at Port Alberni, B. C. Units to be installed include a diesel plant, and total cost will run about $70,000.

Contract has been let for a $600,000 power and water plant for the city of Englewood, Colo. Three 500-kw. oil-burning units are contemplated.

University Park water-pumping station, Denver, has purchased 3,000 hp. of synchronous motors.

Twenty-five projects throughout its system, aggregating $8,000,000, have been approved by Pacific Gas & Electric Co. for the balance of the year.

Dillard University will build an administration building, power plant, library and dormitory building to cost $1,500,000.

A large manufacturer of steam appliances, valves and fittings reports June and July sales largest since last September.

Bayward, Neb., will construct a $200,000 city-owned hydro-electric plant.

Electric power plant equipment, motors and controls, distributing systems, etc., will be installed in group of new buidings, including power plant, to be constructed by Dillard Memorial University, New Orleans, La. Cost over $250,000.

Electric generator, boilers, transformers, etc., will be asked for in bids for city-owned power plant at Ralston, Neb. Estimated cost $96,000.

La Salle & Koch Co., Toledo, Ohio, leading department store and affiliated with R. H. Macy & Co., New York City, is modernizing its power plant with two new generating units. One is rated at 400 kw. and the other 500 kw. They will be driven by vertical uniflow engines.

Bids asked until Aug. 16 by Construction Service, Veterans' Bureau, Washington, D. C., for electric power equipment, including electric refrigerating and ice-making plant, electric elevators, motor-driven ventilating equipment, electrical distribution system and other work at institution at Cheyenne, Wyo.

The Edison Electric Illuminating Company of Boston is installing a 150-kw. outfit for converting alternating-current to direct-current by means of six Phanotron hot-cathode mercury-vapor tubes—another evidence of the growing interest and application of rectifiers for a.c.-d.c. conversion.

Plans authorized by Mountain States Power Co., Tacoma, Wash., for hydro-electric power plant near Stayton, Ore., to cost close to $100,000, with power dam and transmission lines. Unit will replace station destroyed by fire a number of months ago. Site and water rights secured.

Construction program of Montreal Light, Heat & Power Consolidated for the 1932 season will amount to approximately $1,250,000, two-thirds electrical, one-third on the gas lines.

National Sugar Co., Hunters Point, Long Island, N. Y., is installing a 2,500-kw. back-pressure steam turbine, to be in operation by the end of the year. It will take steam from a modern boiler plant recently completed.

Ontario Paper Co. placed a $50,000 order for paper mill machinery, and paid one-third cash with the contract.

Consider what is happening in the textile industry in New England: 2,000 operators have returned to work in Lawrence, Mass . . . A Fall River mill has reopened on a four-day schedule . . . Another mill at Fall River has reopened after a shutdown . . . A blanket manufacturer, with plants in New Hampshire and Massachusetts has reopened, employing about 2,000 men . . . Two textile mills in Rhode Island have reopened giving employment to about 7,250 people . . . A Vermont mill has increased employees from 600 to 1,400 within the last thirty days . . . Another Massachusetts woolen company has added 100 people to the pay roll . . . A velvet manufacturer in Connecticut reports enough orders to require full time with full force for the next six months . . . Another Connecticut velvet mill has orders in hand requiring the operation of its three plants at full force and at 54-hour a week schedule . . . Numerous other mills have reported increased forces and a rubber factory states it is operating double shifts with the largest pay roll in three years . . . A clock manufacturer has called 600 more men back to work.

All these manfacturers are power users and many of them are large consumers of process steam.

New Bulletins

TUBULAR RHEOSTATS—James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa., has issued Bulletin 1330 describing 1932 types of "Jagabi" sliding-contact tubular rheostats.

ROTARY COMPRESSORS AND VACUUM PUMPS — Fuller Co., Fuller Bldg., Catasauqua, Pa., has issued Bulletin C-3 illustrating and describing Fuller rotary compressors and vacuum pumps, both single and two-stage types.

CURRENT METERS FOR WATER MEASUREMENTS—A. Ott, Kempten, Bavaria, Germany, has issued a series of bulletins on making water measurements with current meters. They include: "Making Water Measurements with Current Meters (Reprint from *Power* in English)" "Salzverdünnungsverfahren für Wassermessungen", "Die Genauigkeit einiger Wassermessverfahren," "Wassermengenbestimmungen in Tidegebiet," and "Instruction for Use of Ottmeter V" (also English).

INVENTORY PROCEDURE FOR MATERIALS and SUPPLIES—National Electric Light Ass'n., 420 Lexington Ave., New York City, has issued this report at N.E.L.A. publication No. 230. Price—$0.25 to members, $0.40 to non-members. Another new bulletin (No. 231) is "Purchasing Methods and Routine," at the same prices.

FILLER-TYPE RUST PREVENTER—Dearborn Chemical Co., 310 South Michigan Ave., Chicago, Ill.—Circular on "Filler Red, Gray and Black," describes the NO-OX-ID semi-drying type rust preventives which offer both rust prevention and a cushion bond for paint coating.

FLEXIBLE COUPLINGS—American Flexible Coupling Co., Erie, Pa., a division of J. A. Zurn Mfg. Co.—Bulletin No. 102 illustrates and describes the American flexible coupling.

UNIT PULVERIZERS—Strong-Scott Mfg. Co., Minneapolis, Minn.—Bulletin "Something New Under the Sun," announcing the A-6 Junior Unipulvo unit pulverizer.

AIR FILTERS — Owens-Illinois Glass Co., Toledo, Ohio, has issued a 16-page catalog on air filters, describing the new "Dustop" filters made by that company.

AIR FLOW THROUGH ORIFICES—The Engineering Experiment Station of the University of Illinois has issued Bulletin No. 240, "The Flow of Air Through Circular Orifices in Tin Plates," by Joseph A. Polson and Joseph G. Lowther, which is the second of a series. It is available from the Experiment Station for 25 cents.

BOILER NOZZLES—Worth Steel Co., Claymont, Del., has issued Catalog No. 1 on Worth "Blue Band" plate steel boiler nozzles, giving sizes and specifications.

BLOWERS AND METERS—Coots-Connersville-Wilbraham, Connersville, Ind., have issued Bulletins Nos. 40-B10 and 170-B10, the first describing Connersville rotary displacement meters, and the second covering R.C.W. centrifugal blowers and compressors.

COKE AND BY-PRODUCTS—The Bureau of Mines of the Department of Commerce has issued a report, "Coal and By-Products in 1930," by Walter H. Voskuil, F. G. Tryon and H. L. Bennit, which is available from the Superintendent of Documents, Washington, D. C., for ten cents.

COMPRESSORS AND VACUUM PUMPS—Fuller Co., Catasauqua, Pa., has issued Bulletin C-3 on single- and two-stage compressors and vacuum pumps.

JET CONDENSERS AND AUXILIARIES—Pennsylvania Pump & Compressor Co., Easton, Pa., has issued Bulletin No. 411, describing jet condensers and auxiliaries for vacuum processes, which will be marketed by Byer Engineering Associates, 75 West St., New York, N. Y.

WATER POWER—The Conservation Department of the State of New York has issued its fifth annual report of the Division of Water, Power and Control for the year ending December 31, 1931.

WIRE ROPE—John A. Roebling Sons Co., Trenton, N. J., has issued a booklet, "The Splicing of Wire Rope," describing the methods of splicing wire rope employed in that company's shops, illustrated for convenience of users.

UNIT PULVERIZERS—Riley Stoker Corp., Worcester, Mass., has issued a catalog, "Riley Atrita Unit Pulverizers," describing the methods of construction and operation of these units.

TUBE CLEANERS—Lagonda Mfg. Co., Springfield, Ohio—24-page catalog X-12 describes its general line of tube cleaners, also Bulletin X-13, covering Series 450 cleaners for oil stills.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Paso Robles—City plans to build municipal power plant and is in the market for 150 hp. diesel engines. L. Henry, city clerk.

Conn., Stonington—Mystic Valley Water Co., 129 Water St., will build filtration plant. Equipment including diesel engine will be installed. Estimated cost $50,000. Northeastern Public Service Co., c/o J. S. Wise, Portland, Me., in charge.

Ill., Belvidere—City is having plans prepared by Burns & McDonnell, engrs., 406 Interstate Bldg., Kansas City, Mo., for light plant.

Ind., Madison—State Board of Health plans to build new water plant using diesel engines. Estimated cost $10,500. George J. Miesse, Madison, clerk.

Ky., Paris—City Commissioners receiving bids for light and power plant. Estimated cost $150,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., engrs.

Mo., Pacific—City had preliminary surveys made for light and power plant and distribution system. Estimated cost $75,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, engrs.

Mo., St. Charles—City plans $300,000 bond issue to build light and power plant. Russell & Axon, engrs., Roosevelt Bldg., St. Louis, prepared preliminary survey

Mo, St. Louis—Carl G. Stifel, pres., John H. Gundlach Real Estate Co., 3600 North Bway., applied to Federal Power Comn. for permit to build hydro-electric dam and power plant on Mississippi River near Chain of Rocks. Proposed plant would generate 175,000 hp.

Neb., Ainsworth—City is having plans prepared by R. Fulton, 2327 South 19th St., Lincoln, archt. and engr., for light and power plant and electric distribution system. Equipment including two diesel engines will be installed. Estimated cost $85,000.

Neb., Bayard—City is having plans prepared by Franklin P. Wood, 810 14th St., Denver, Colo., for hydro-electric plant in Hoth Canyon. Plant will probably furnish light to Bayard, Minatare and Scottsbluff. Estimated cost $200,000.

Neb., Ralston—City will soon receive bids for light and power plant and distribution system. Equipment will include two 360 hp. diesel engines with generators and exciters, switchboards, etc. Estimated cost $85,000 to $90,000. C. V. Barnhill, 420 Federal Trust Bldg., Lincoln, engr.

N. J., Hoboken—Castle Laundry Co., 81 Gifford St., Jersey City, plans to alter plant at First and Harrison Sts., into laundry. Complete equipment will be required.

N. J., Newark—Royal Laundry Service, Inc., 771 South 16th St., is having revised plans prepared for altering and building addition to laundry. Estimated cost $40,000. Garrabrant & Zumbusch, 380 Main St., East Orange, archts.

N. J., Perth Amboy—Raritan Copper Works, foot of Elm St., plans to rebuild power plant recently destroyed by fire. Estimated cost $40,000.

N. Y., Alfred—Comr. of Education, Education Bldg., Albany, will receive bids until Aug. 11 for heating work and service connections at School of Ceramics and School of Agriculture and Dairy Building, Alfred University.

O., Cleveland—City will receive bids until Aug. 11 for heating and ventilating system for underground Exhibition Hall. Estimated cost $105,000. W. S. Lougee, City Hall, engr.

O., Cleveland—City is having plans prepared for pumping station at Parma Reservoir. Estimated cost $250,000. E. Linders, City Hall, engr.

O., Mansfield — Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., plans to build warehouse and will be in market for three 65 ft. cranes.

Pa., Lancaster—City having plans prepared by J. N. Chester Engrs., Blark Bldg., Pittsburgh, for two sewage disposal plants, including pumping machinery and blowers. Cost $900,000.

Pa., Pittsburgh—City is having preliminary plans prepared for heating plant for Schenley Park Conservatory, $27,000; also reconstructing heating plant at North Side Conservatory, $5,000.

R. I., Providence—M. N. Cartier & Sons Co., 275 Canal St., plans to build a factory on Canal St., including a power house, and is interested in prices of equipment. Estimated cost $50,000.

Tex., Sulphur Springs—City having plans prepared by Burns & McDonnell Eng. Co., engrs., 400 Interstate Bldg., Kansas City, Mo., for power plant.

Utah, Ogden—State Bldg. Comn., Salt Lake City, plans new heating plant at State School for Deaf & Blind. Estimated cost $50,000. R. K. Brown, Salt Lake City, state engr.

Wash., Seattle—Superv. Archt., Treas. Dept., Wash, D. C., will receive bids until Aug. 17 for transformers and electric service in U. S. Marine Hospital.

Wyo., Cheyenne — Veterans Administration, 764 Arlington Bldg., Wash., D. C., will receive bids until Aug. 16 for hospital, including electric elevators, refrigerating and ice making machinery.

Ont., Hamilton—Hydro Electric System of Hamilton, 12 King St., E., plans outside transformer station to serve southeastern end of city. Estimated cost $25,000. Complete equipment will be required. E. I. Sifton, ch. engr.

Ont., Sarnia—Sarnia Arena Co., 418 Talfourd St., plans new arena on North Christina St. Prices wanted on artificial ice equipment. Estimated cost $60,000 to $70,000. L. Fawcett, 159½ Lochiel St., archt.

Que., Westmount—City Council plans to increase generating capacity of power plant.

Equipment Wanted

Motor Driven Pumping Units—Wash., D. C.—U. S. Engineers Office, War Dept., receiving bids for 4 vertical motor driven pumping units for booster pumping plant.

Motor—Saugus, Mass.—Malden Crushed Stone Co., 821 Bway., plans to purchase 200 hp. slip ring, 3 bearing a.c. motor, 450 r.p.m., 220 or 440-volt 3 phase.

Electric Generator—Kings Park, N. Y.—Comr. of Mental Hygiene, Albany, will receive bids until Aug. 24, for electric generator for Kings Park State Hospital.

Boilers, Engines, etc.—Hepner, Ore.—Anderson, Eckles & Feeley, Hepner, are in the market for boilers and engines for planing mill.

Boiler—Slippery Rock, Pa.—J. N. Chester, engrs., Clark Bldg., Pittsburgh, Pa., plan to purchase one 200 hp. boiler with alternate on 250 hp. boiler, for State Teachers College, Slippery Rock.

Generator Set—Chattanooga, Tenn.—Dorsey Leather Co., Signal Mountain Rd., is in the market for diesel engine generator set or steam-electric generator set suitable for plant with 10 motors ranging from 1 to 10 hp. and totaling about 25 hp.

Power Plant Equipment—Austin, Tex.—University of Texas, J. W. Calhoun, comptroller, Austin, will receive bids until Aug. 15 for two turbo generators with exciters, surface condensers and all required auxiliaries and accessories. C. J. Eckhart, Jr., supt. of power plants.

Pumps, Valves, Meters, etc.—Milwaukee, Wis.—O. H. Henschel, engr., 744 North 4th St., receiving bids for pumps, valves, steam flow meters, etc., for new boiler plant for Federal Pressed Steel Corp., 714 East Keefe Ave.

Transformers—Sydney, Australia—City Clerk will receive bids until Oct. 17 for four 9,000 kva., 60 cycle, oil immersed forced oil cooled, 3 phase 3 circuit type transformers for Pyrmont power station.